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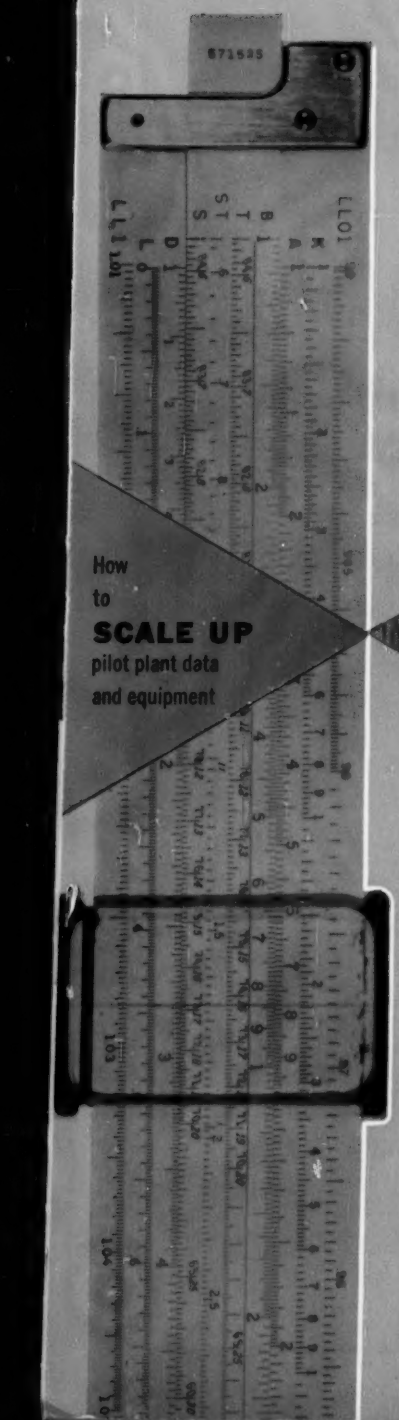
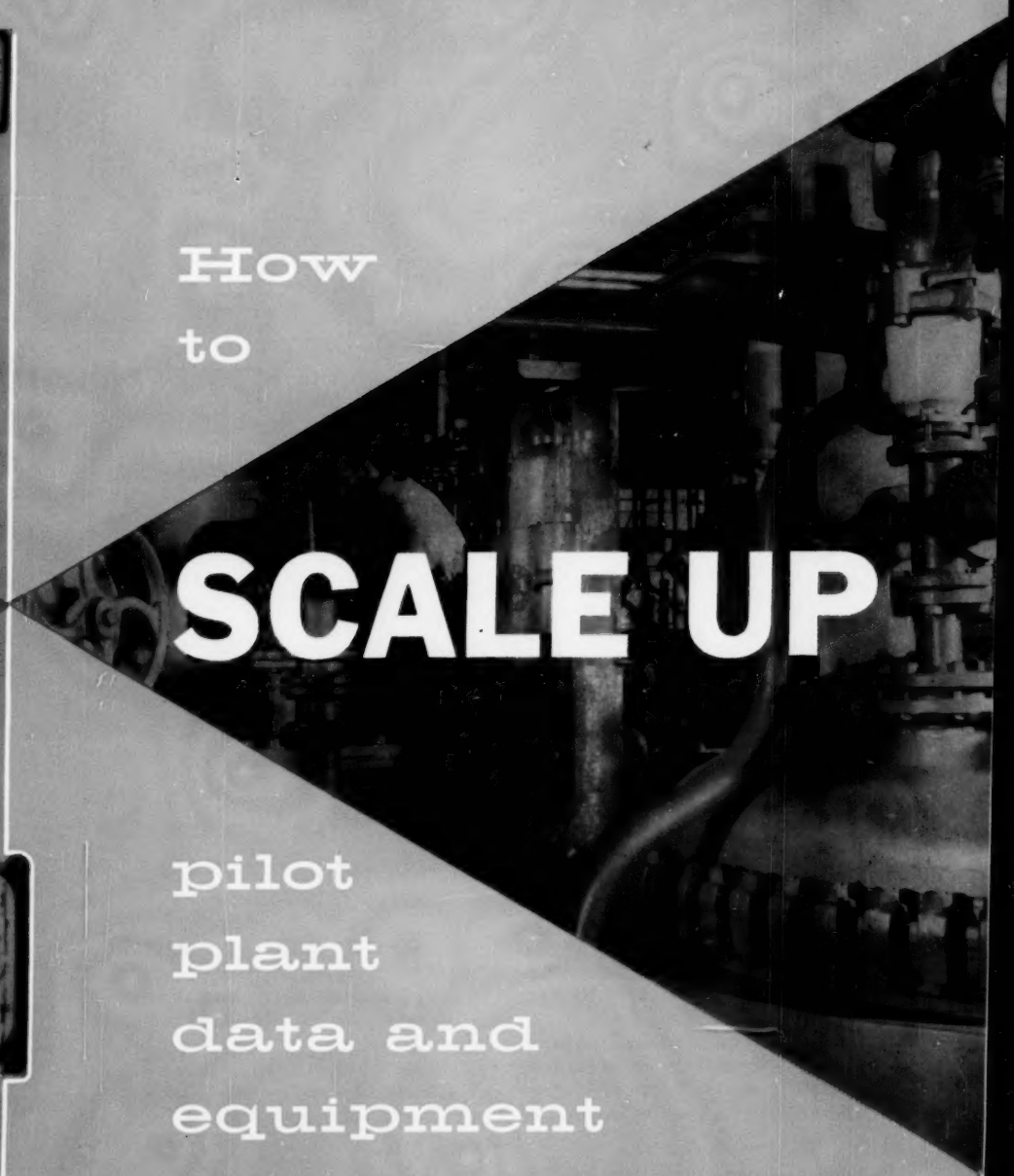
Chemical Engineering

A McGRAW-HILL PUBLICATION

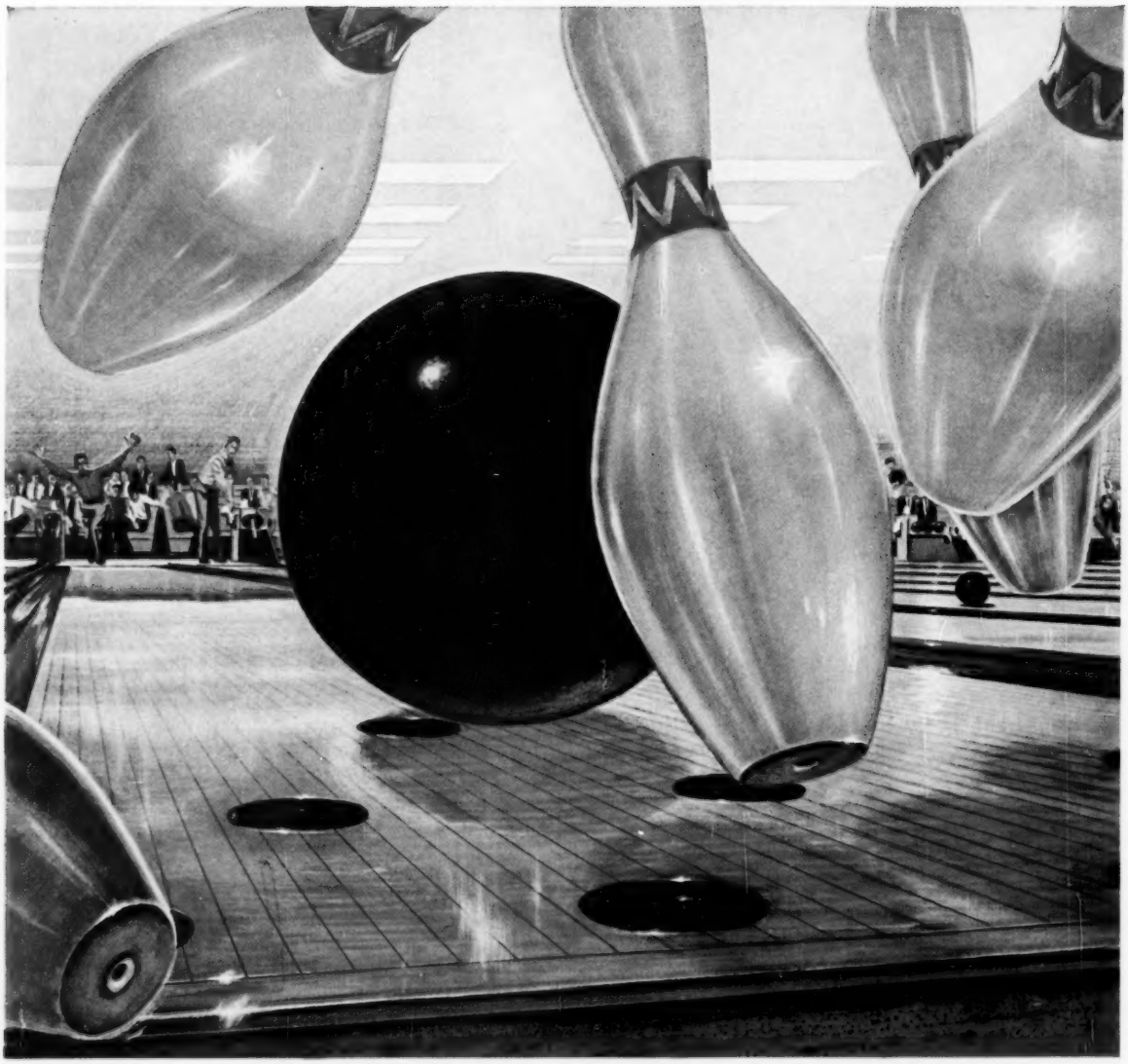


How to SCALE UP pilot plant data and equipment



How to SCALE UP pilot plant data and equipment

FROM PILOT PLANT TO FULL SCALE
QUICK HEAT TRANSFER DESIGN
ENGINEERS ON STRIKE
SEE PAGE TWO



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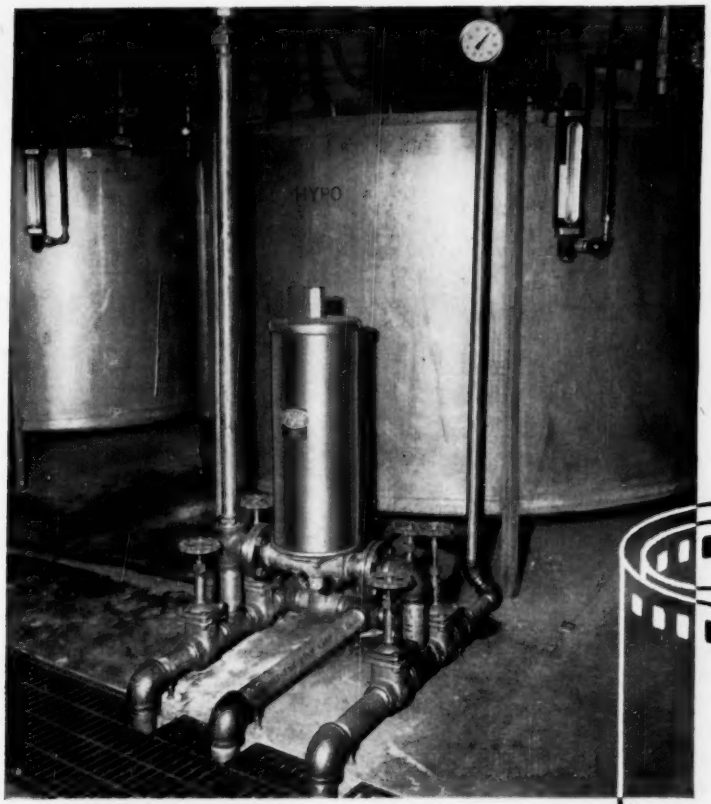
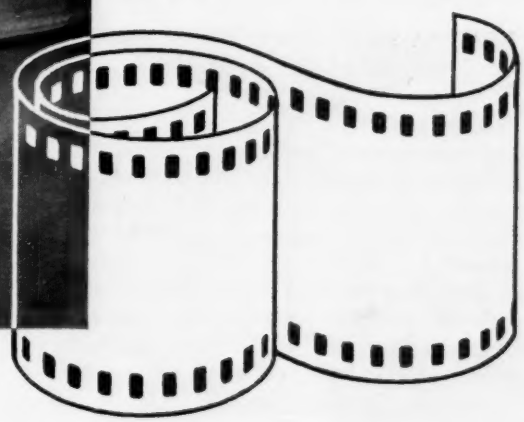


Stainless Steel Fulflo Filters with 18 Honeycomb Filter Tubes remove micro-contaminants from acid baths used in processing motion picture films at De Luxe Laboratories in Hollywood. Flow rate is 54 gpm.

Fulflo Filters "GO HOLLYWOOD"



Maintain micro-clarity of film process solutions for De Luxe Laboratories

Fulflo Filters are helping to turn out higher quality films — for the movies and television — at De Luxe Laboratories, Incorporated, in Hollywood. All film processing solutions are filtered to micro-clarity so that not one speck of dirt can get in the finished film. In addition to improving film quality, Fulflo Filters have brought about substantial savings in prolonged fluid life.

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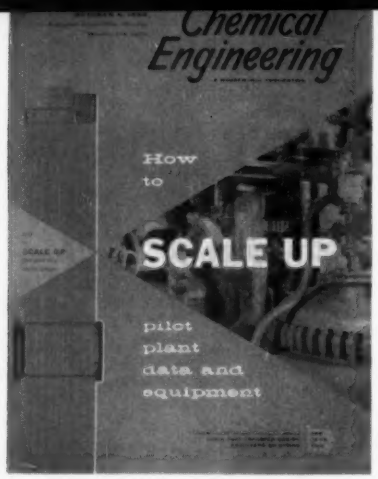
Write for new catalog to Department CE

COMMERCIAL FILTERS CORPORATION
MELROSE 76, MASSACHUSETTS
PLANTS IN MELROSE, MASSACHUSETTS AND LEBANON, INDIANA

MICRO-CLARITY AT MINIMUM COST

Fulflo Filters — *with genuine Honeycomb Filter Tubes for controlled micro-clarity of industrial fluids.*

CFC Filters — *Selective filtration of oils • water-oil separators • magnetic separators • pre-coat filters • coolant clarifiers • automatic tubular conveyors.*



Chemical

OCTOBER 6, 1958

TWENTIETH OF TWENTY-SIX ISSUES

20/26

Best way to grow oaks from acorns

Here's how to successfully and painlessly extrapolate your pilot-plant data and equipment into a full-size working plant. You'll be able to thread a much safer course through a maze of problems: heat and mass transfer, process rates, equipment geometry. Now you'll be better able to convert your reaction and other small-scale facts into a set of logical and usable relationships for big-scale planning. (p. 129)

Up-to-the-minute costs

This time we've some U-tube heat exchanger curves. They'll convert heat transfers area into fob. dollars—a mightly big help with your preliminary cost estimates. They're part of a new series of provisional standards and we'll bring you more. (p. 141)

Three answers from one chart

Single new chart is latest aid for your countercurrent extraction operations, even if they're multistage. It quickly finds your optimum economic conditions. It's another time-slasher; a simple way to cut out needless figuring. (p. 142)

To keep siphons in their prime

Always-ready siphon is a smart way to keep tank levels under control. Especially where your under-liquid connections are hard to make—or impossible. Where can you use this prize-winning idea? (p. 153)

Developments in Chemical Engineering

Practice of Chemical Engineering

Engineering

Vol. 65, No. 20

CE is edited for the engineers who develop, design, build, operate, maintain and manage chemical operations of all types. More engineers subscribe to CE than to any other magazine in the field. Print order of this issue:

48,247

Chemical Engineering

This issue's top features in ...

Petrochemicals & Petroleum Refining

There's renewed activity in petrochemicals 68

More petroleum-derived products are coming from the processing line: Epoxies and other oxygenated chemicals; nine chlorinated xylenes now in pilot plant production.

Cat cracker's size challenges engineers 120

Tidewater Oil's Orthoflow fluid cat cracker represents 9,500 tons of processing bulk, charges a whopping 102,000 bbl./day. Designers solved some challenging problems.

Hoping for trouble-free scale-up? 129

This 12-page feature report—final installment in our pilot-plant series—will give you expert help in using pilot-plant data for production scale-up.

Here are up-to-the-minute heat exchanger costs 141

Sleuthing for timely, reliable sources of cost information? Here's the first of a series of cost charts, based on data from the American Assn. of Cost Engineers.

Use this chart for extraction design problems 142

Now, one chart gives optimum values for the many variables in multistage, countercurrent operations. Chart works for systems of linear and moderately linear distribution.

OCT. 6, 1958

Also of Basic Interest

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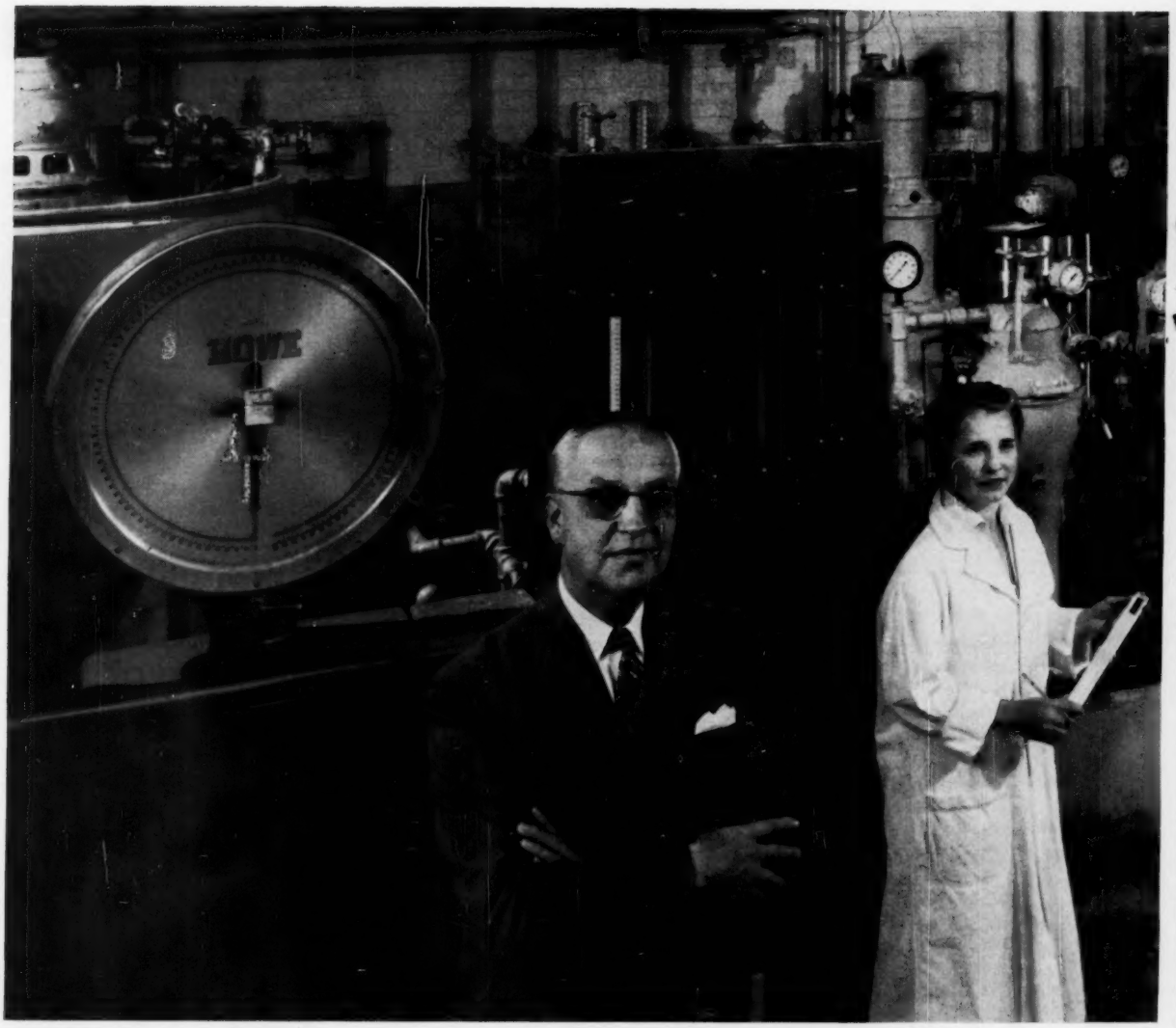


"De Laval's pilot plant simulates your process conditions to solve centrifugal processing problems."

Fred Wheelwright, De Laval Separator Company

"The photograph above shows the major portion of De Laval's pilot plant setup at our Poughkeepsie, N. Y., headquarters . . . and some of the key people responsible for its operation.

Basically, what we provide here is a complete centrifugal processing facility in which you can test your processes without having to build your own pilot plant. We find the answers to problems concerning separation, clarification, classification or concentration of liquid-liquid-solid or liquid-solid mixtures. These findings are then applicable to the operation and/or construction of your own process facilities.

Facilities: Our plant has the capacity to handle samples in reasonable production quantities. It has stages for mixing, reaction, heating and three stages of separation . . . followed by a continuous high vacuum dryer. Most of the equipment is stainless steel to permit us to handle corrosive liquids. We've found very few situations in which we could not simulate process conditions well enough to give an accurate reading on process efficiency or feasibility.

Examples: We've done work here for many of the country's leading chemical companies. Typical examples of the problems we've handled are:

- removing oversize particles from polyvinyl latex.
- continuous high-volume removal of uranium salts from loaded solvents.
- removing catalysts from re-arranged lard.

And one of the best-known products of this pilot plant is the patented De Laval tall oil process. The patent on this continuous acidulation process (full information on request) is based on work done here by our Manager of Industrial Engineering, Frank Sullivan.

Personnel: In the center of the picture: Frank Sullivan, B.Ch.E. at N.Y.U., and a Master's at Stevens Institute . . . one of the country's foremost authorities on centrifugal processing, has published many papers on various aspects of centrifugal technology. With De Laval since 1950, Mr. Sullivan is responsible for the engineering development of all De Laval's industrial equipment and processes, and for the industrial laboratory and process laboratory.

Next to Mr. Sullivan is Mrs. Lois Crauer, B.S. degree from U. of Rochester, a member and active in the A.C.S. and A.O.C.S. Undoubtedly one of the best-known authorities (and certainly one of the prettiest!) in the field of vegetable oil processing, Lois Crauer's work at De Laval places particular emphasis on development of chemical processes.

At the far right of the picture is Victor Lindenman, Jr., Chemical Engineer (Northeastern University) responsible for direct supervision of the pilot plant. Between him and Mr. Sullivan is Lowell Signor, Jr., Test Man responsible for operation and maintenance of the pilot plant equipment. And that's me, Fred Wheelwright, on the left.

What's in it for you? We welcome your inquiries on problems we might help you solve. We charge a rather nominal day-rate fee, and we insist that we have the opportunity to run lab tests on *small samples* of your material before we decide whether to set up for pilot plant testing. In any case, you can be sure that your inquiry will receive our undivided attention, and there will be no obligation."

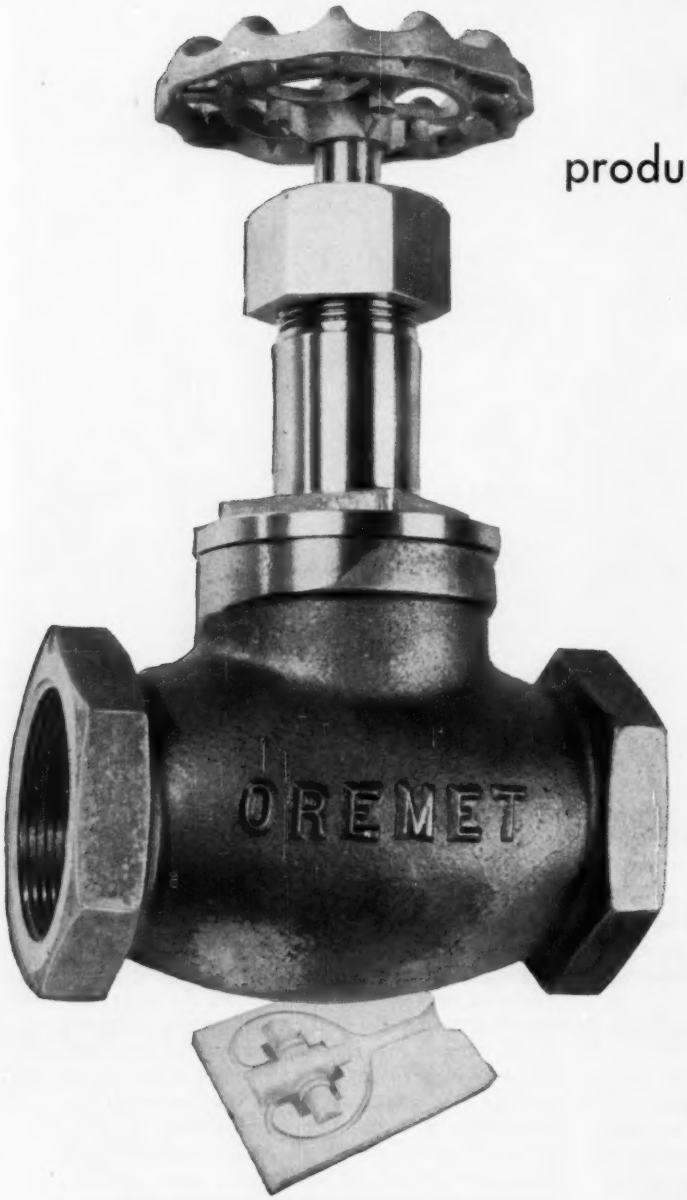
DE LAVAL
SEPARATOR COMPANY

THE DE LAVAL SEPARATOR COMPANY
Poughkeepsie, New York
Chicago, Illinois

DE LAVAL PACIFIC COMPANY,
201 E. Millbrae Avenue, Millbrae, Calif.

TITANIUM—available now for long service

NOW AVAILABLE: TITANIUM CASTINGS



• **This 2″ titanium globe valve,** cast by Oregon Metallurgical Corp., is corrosion-resistant, has low density with a tensile strength up to 90,000 psi. Such castings are now possible by use of an expendable graphite mold composition developed through Du Pont research.

New casting technique produces sound, high-quality shapes at fraction of machined part cost

For the first time, *cast* titanium shapes are readily available—such as the globe valve pictured at left. One piece or a hundred can be produced at reasonable cost. This important development was made possible through the efforts of skilled foundrymen working with a new rammed graphite mold composition developed by Du Pont.

Sound, high-quality titanium castings are highly resistant to many corrosive environments such as hypochlorite slurries, brackish water and chlorinated organic compounds. Result: long service life, reduced downtime, lower initial and operating costs.

PIGMENTS DEPARTMENT

DU PONT
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BETTER THINGS FOR BETTER LIVING ... *THROUGH CHEMISTRY*

PIONEER PRODUCER OF

TITANIUM

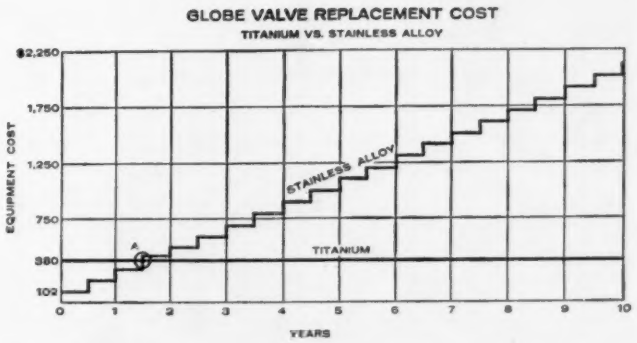
life . . . corrosion resistance . . . economy in use

Proven Economies

Titanium is actually the *least expensive* metal you can use under many corrosive influences. It withstands conditions that reduce the service life of ordinary and high-alloy metals . . . cuts downtime and replacements.

Titanium offers the economy of long, trouble-free service when exposed to such corrosive environments as:

- Salt Water
- Marine Atmospheres
- Nitric Acid
- Wet Chlorine
- Chlorinated Organic Compounds
- Most Inorganic Chloride Solutions
- Molten Sulfur
- Chromic Acid
- Aqua Regia
- Hypochlorites and Chlorine Dioxide



GREATER ECONOMIES are now possible through use of cast titanium valves. Stainless alloy and titanium globe valves were tested in an environment of 65% nitric acid at 110° C. Stainless alloy valve cost $102* . . . but had a *maximum* service life of only 6 months (some lasted only 3 months). The titanium valve cost $380*, showed no sign of corrosion after 6 months. Life expectancy: 10 years *minimum*. The $278 difference in cost was absorbed in less than 1¼ years (Point A). After 10 years, a single titanium valve will save more than $1,750 in replacement costs alone!

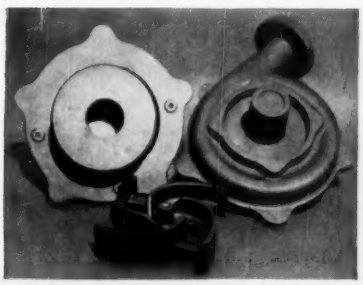
** cost of single unit*

TITANIUM—available today

Titanium is now readily available for non-defense applications. Standard parts of titanium are already solving severe corrosion problems in the chemical, food, pulp, paper and allied industries.

In your process development work, take advantage of the corrosion and cavitation resistance, light weight, long life and high strength of titanium in continuous flow, high temperature and pressure processes.

As a manufacturer and pioneer producer of titanium sponge, Du Pont has been working with leading mill-products producers and process-equipment manufacturers on the commercial development of titanium. This broad experience can be applied to *your* process development, equipment design and plant maintenance problems. Just get in touch with Du Pont for further information about titanium—its properties and uses.



NOW AVAILABLE — *Cast* titanium parts and fitting like the centrifugal pump, diaphragm-type valve, and 5-in. IPS "Y" valve and accessories pictured above. These are just a few examples of commercial castings made of corrosion-resistant titanium.

MAIL COUPON TODAY for an informative booklet about titanium—its properties and applications. E. I. du Pont de Nemours & Co. (Inc.), Pigments Department, Titanium Market Development Section, Wilmington 98, Delaware. (This offer is limited to the United States and Canada.)

SPONGE

E. I. du Pont de Nemours & Co. (Inc.)
Titanium N-2420, CE-10, Wilmington 98, Delaware

Please send ☐ booklet on titanium, ☐ information on cast-titanium parts. I'm interested in titanium for the following applications: _____

_____

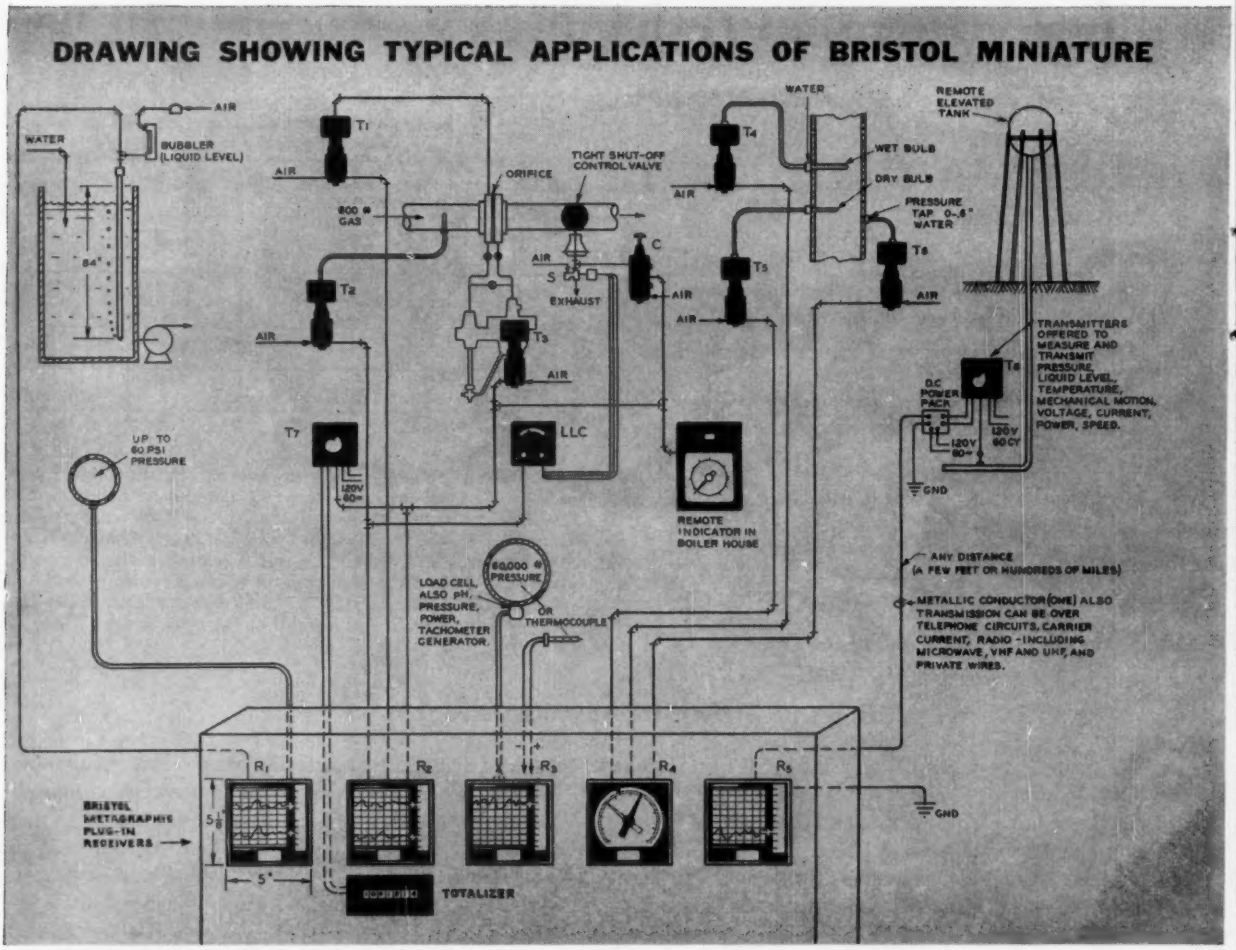
Name _____ *Title* _____

Firm _____

Address _____

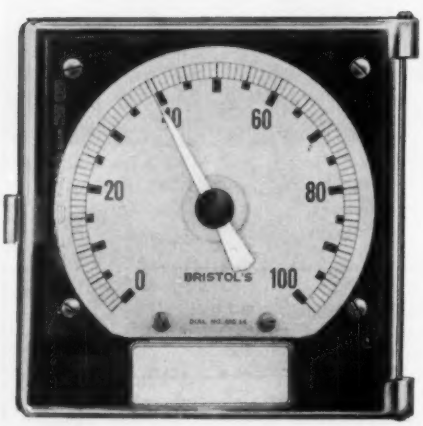
City _____ *Zone* ____ *State* _____

(Offer limited to the United States and Canada)



ALL RECEIVERS LOOK ALIKE ON GRAPHIC PANEL, and all take the same panel cutout (4 9/16" sq.)

Bristol offers: **More types of miniatures**



BRISTOL METAGRAPHIC INDICATORS feature easy-to-read 9-inch effective length scale and interchangeability with recorders of same type.

Bristol Miniature Instrument Systems offer broadest measurement range and widest process control coverage:

- ***Pneumatic Transmission***
- ***Electronic Potentiometers and Bridges***
- ***Telemetering Instruments***
- ***Recording Gauges***

Automatically Controlling, Recording, and Indicating Models

INSTRUMENT SYSTEMS

LEGEND

BRISTOL* METAGRAPHIC TRANSMITTERS

T_1 Pressure
T_2 Temperature
T_3 Differential Pressure or Flow
T_4 Temperature (Wet Bulb)
T_5 Temperature (Dry Bulb)
T_6 Pressure (as low as 0 to 5 mm mercury)
T_7 Integrator
T_8 Liquid Level Metameter Telemeter

*Metagraphic Transmitters are available for temperature, pressure, vacuum, differential pressure, flow, liquid level, mechanical motion, and through the use of the Bristol Dynamaster† Electronic Transmitter any input signal in the form of voltage, current, or change of resistance, capacitance, or inductance such as pH, speed, strain, density, etc.

BRISTOL RECEIVERS

R_1 Pressure or/and Liquid Level Recorder
R_2 Metagraphic Recorder (up to 2 records and 1 indicator)
R_3 Dynamaster Electronic Potentiometer or Bridge
R_4 Metagraphic Indicator—one, two, or three pointers for wide range of measurements or two pointers and one manual remote control.
R_5 Metameter† Telemeter

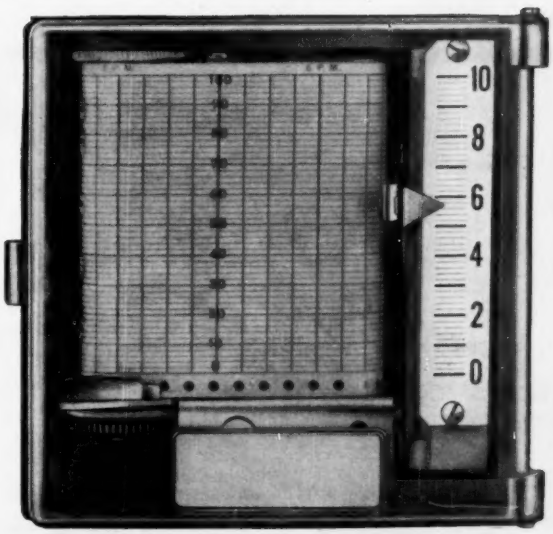
†T. M. Reg. U. S. Pat. Off.

BRISTOL METAGRAPHIC CONTROLLERS

(36 models to choose from—by far widest variety available)

Five Modes of Control

1. On-Off (Fixed High-Gain)
2. Proportional (Adjustable Gain)
3. Proportional-plus-Reset
4. Fixed-Proportional plus Fast-Reset
5. Proportional-plus-Reset-plus Derivative



BRISTOL METAGRAPHIC MINIATURE RECORDERS
—whether electronic, pneumatic, telemetering, or gauge types—present a uniform, pleasing easy-to-read panel appearance, measure only 5″ x 5 1/8″, fit same 4 9/16″ square panel cutout.

than any other instrument company

. . . plus a complete line of full-sized instruments

Bristol makes them all. Whatever your choice in instruments, you need look no farther than the complete Bristol line—pneumatic, electronic, miniature telemeters and gauges—all in a *planned* line.

Planned to give graphic panel installations a neat, pleasing, matching appearance.

Planned to give you the widest possible measurement range, the broadest instrument coverage, of any line.

Planned to free you from costly pre-installation decisions as far as practically possible—true plug-in instruments; widest practical number of instrument substitutions; easiest, fastest range changes.

Planned to give you any type of instrumentation—electronic, pneumatic or mixed systems in plug-in miniature construction.

Planned to give you the results of modern human-engineering studies in chart, dial, and indicator visibility and readability.

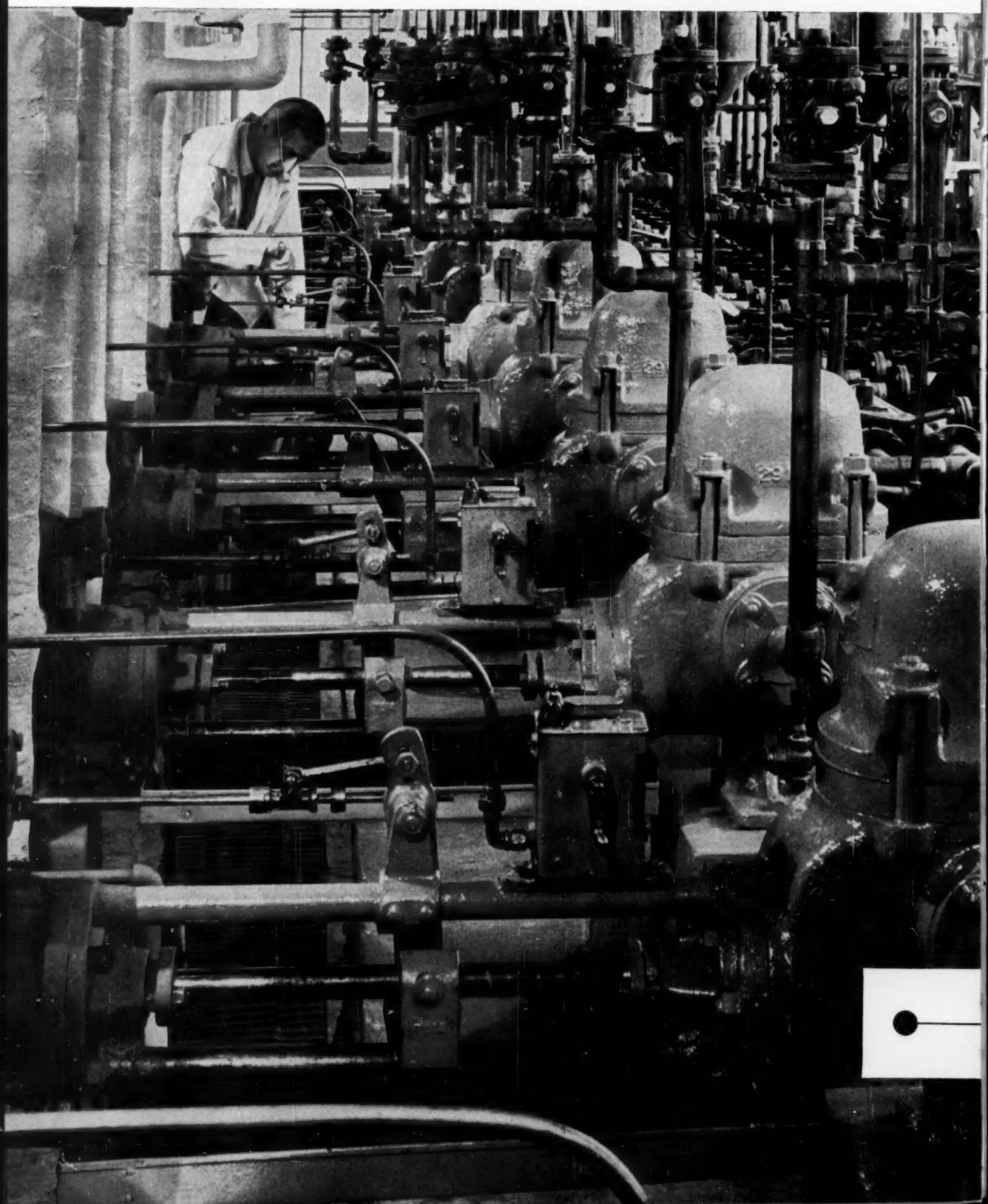
Bristol makes all types, all sizes of instruments, can give you all control modes. That's why Bristol application engineers don't need to shade the facts. When they make an instrument recommendation it's based on our unbiased consideration of *your* problem alone.

Write for complete technical data on Bristol miniature instruments today. The Bristol Company, 109 Bristol Road, Waterbury 20, Conn. B-6

BRISTOL *TRAIL-BLAZERS IN PROCESS AUTOMATION*

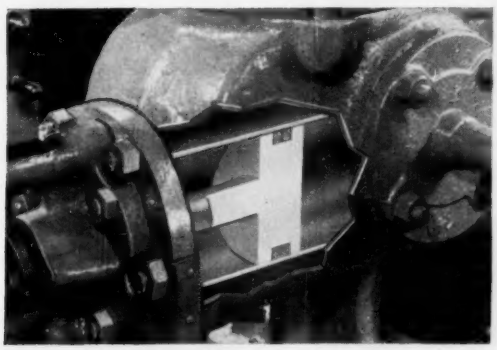
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

Garlock Lattice-Braid* Teflon† Packings help Kodak



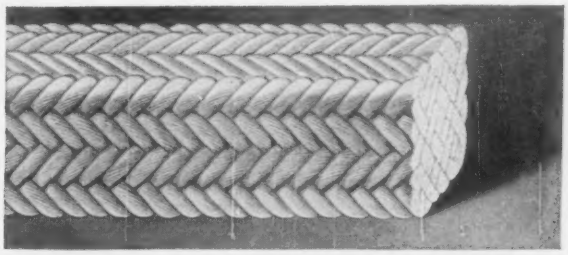
Recover 95% of Film Process Solvent for Re-Use

TODAY, at Eastman's Kodak Park Works in Rochester, Garlock LATTICE - BRAID Teflon packings are playing an important role in helping to recover, for later re-use, 95% of the solvents used annually in the coating of film.



DOING A JOB that neither rubber-impregnated canvas, duck, or other packings could do in the past, the LATTICE-BRAID Teflon packings provide tight seal up to 100 psi pressure in more than 100 pumps which move solvents from underground storage to various distilling operations where it's refined and prepared for use again. As part of the piston that furnishes pumping compression, the packings are constantly exposed to the solvent mixture and must be able to withstand its action without swelling or deterioration. In addition, the packings must create as little friction—and resulting wear—as possible on the cylinder liners while the piston moves at rates as high as sixty 12″ strokes per minute.

Garlock LATTICE-BRAID Teflon Packings have provided reliable service, without shutdowns for maintenance, as well as increased pump efficiency due to reduced slippage. There is also a lower coefficient of friction of packing to cylinder liner, while the liners themselves appear to remain in excellent condition.



LONGER OPERATING LIFE of both pump and packing lies in Garlock's use of Teflon yarn woven in lattice - braid construction. Each strand of Teflon passes diagonally through the body of the packing at an angle of approximately 45°. This through-and-through braiding makes a completely unified structure, resulting in greater strength. Garlock's LATTICE-BRAID has no outer cover to wear through; its through-and-through structure holds together when worn far beyond the limit of ordinary packings, resulting in longer packing life.

ADD to these features the fine physical properties of the Teflon yarn—chemical inertness, low friction coefficient, temperature stability, excellent cold-flow resistance—and you have the finest packing on the market.

LATTICE-BRAID Teflon Packing is another important part of "the Garlock 2,000" . . . two thousand different styles of packings, gaskets, and seals to meet all your needs. The only complete line. That's why your Garlock representative can give you unbiased recommendations. Call him or write for Folder AD-131.

*Registered Trademark
†DuPont Trademark

Ten of the reciprocating pumps used in solvent recovery at Kodak. Garlock LATTICE-BRAID Teflon Packings on the pump pistons have given satisfactory service since the first installation 2 ½ years ago.

THE GARLOCK PACKING COMPANY, Palmyra, N. Y.
FOR PROMPT SERVICE, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products

MEASURING UNIT

A. A thermocouple signal to a d'Arsonval galvanometer, the only moving part, moves the indicating pointer up scale.

B. Aluminum vane adjusts the amount of light received by the photocell from the operating lamp.

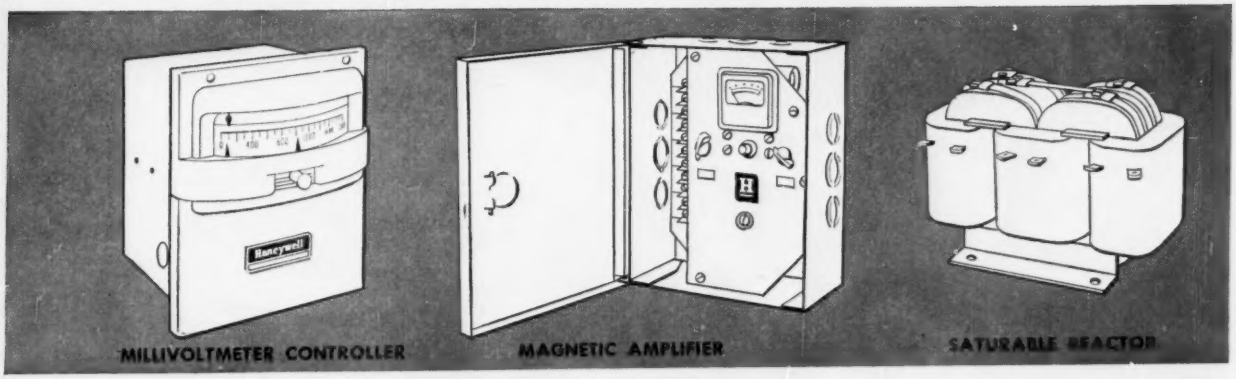
C. If operating lamp or photocell fails, output voltage assumes a value equal to high temperature.

CONTROL UNIT

D. A one-stage magnetic amplifier amplifies small current from the photocell in the measuring unit. This is the only active electronic element in the controller.

E. Pilot light goes out on line power failure.

***Pyr-O-Volt* controller is dependable and trouble-free. Built-in voltage regulator maintains voltage within ±1% of level required for maximum operating stability. Thermocouple burnout protection is optional. Spare operating lamp is supplied with all instruments. Available in both horizontal and vertical case models.**



For your electric heating applications...

Use this accurate, dependable *Pyr-O-Volt** controller

- **No tubes to wear out**
- **Voltage regulation**
- **Fail-safe design**
- **Contactless, stepless control**

Here's an accurate instrument for reliable stepless control of saturable reactors, r.f. generators and other power amplifiers. It has a proportional band adjustable from ⅔% to 5%, and a manual reset adjustment which shifts the control point over 100% of the proportional band.

The *Pyr-O-Volt* controller can control saturable core reactors up to 100 kva, if used with a Brown magnetic amplifier. You can also use this proportional output millivoltmeter-controller with the General Electric *Reactrol***, and with the Westinghouse *Furnatron*.*** Complete packaged systems available.

Contact your nearby Honeywell field engineer for complete details. He's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

H HONEYWELL *First in Control*

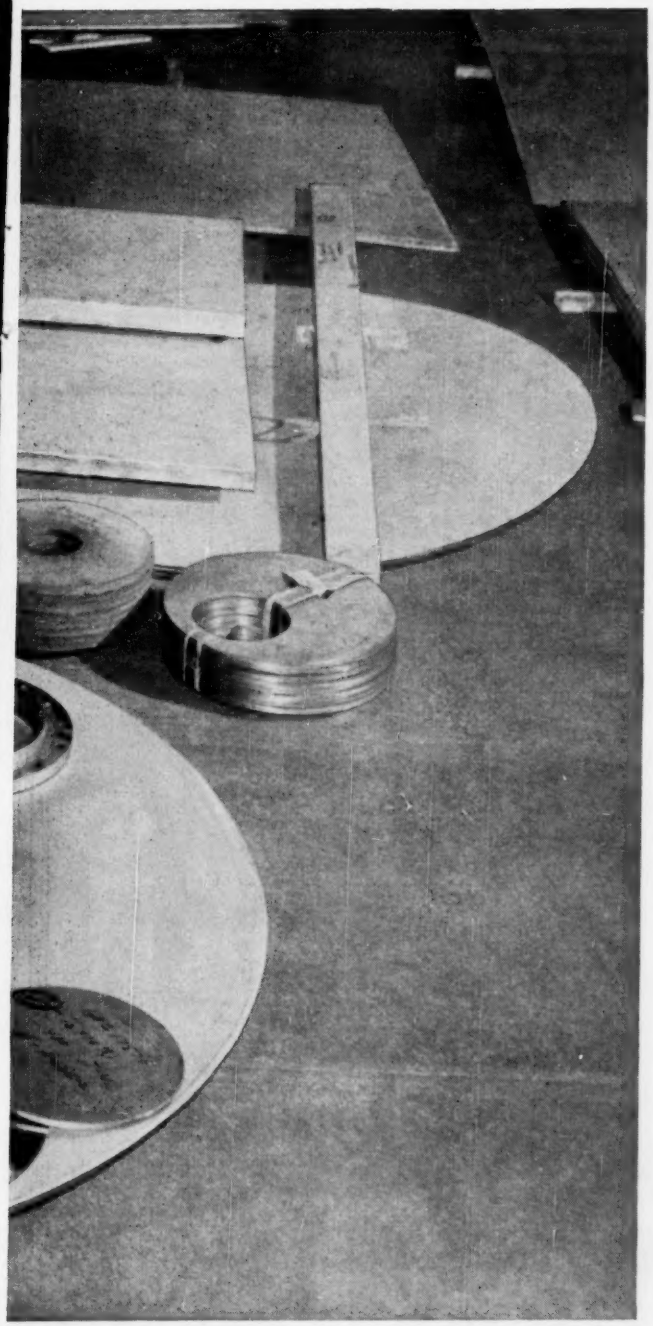
● **REFERENCE DATA: Specification S103-5**

*Tradename, Minneapolis-Honeywell Regulator Co.
**Tradename, General Electric Co.
***Tradename, Westinghouse Electric Corp.

12"x 2" Disc or 200"x 132"x 2" Plate

...Carlson is your ONE source for ALL stainless steel components

STAINLESS STEEL PLATES • PLATE PRODUCTS • HEADS • RINGS



Check your drawings and you may find that you require all of the stainless steel items shown here—plates, heads, tube sheets, discs, forgings, flanges, rings, special patterns, bars, and sheets (#1 Finish) in the heavier gauges. When you buy all these material components from one source you save time, effort and money.

Your assembly costs are kept to a minimum when you use Carlson's abrasive cut material. Cleaner edges mean less true-up time on the job. There is no heat-affected zone because little heat is developed during the cutting. Fabrication is easier and the finished product is of the highest quality, more dependable in use.

Who pays freight on "offcuts" you can't use? No one, when you use Carlson's service for cutting plate to shape, ready for your fabrication. Plate is sheared, sawed, flame or abrasive cut and machined to your specifications. Eliminating freight charges on excess material lowers your costs.

There's the matter of delivery which also means time and money to you. As specialists in stainless steels, Carlson has the diversified equipment and the technical and practical knowledge to produce the plate or shapes you want, the way you want them with delivery as promised.

Stainless Steels Exclusively

G. O. CARLSON Inc.

THORNDALE, PENNSYLVANIA

District Sales Offices in Principal Cities

DISCS • FORGINGS • FLANGES • BARS AND SHEETS (No. 1 Finish)

Holiday destination-

Saturday problem: Damaged 8,000 gallon reactor

Sunday job: Trouble-shoot and repair

Monday result: Reactor back "on-stream"

It's nine Saturday night. Home phone rings long distance. It's a Texas customer's voice: "One of our 8,000 gallon reactors was damaged. How soon can you fix it?" Answer: "Trouble-shooter leaving earliest flight." Glascote service engineer packs. Takes-off 7 a.m. Sunday. Repairs completed 10:30 that night. Monday — and he's up early. Repairs inspected. Reactor started up and back "on-stream."

Case in point: Every Glascote customer is automatically enrolled in our life-long preventive maintenance and flight-fast service programs!

Our objective: *Protecting profitability of your Glascote glass-lined equipment.* This basic protection program includes process engineering and consulting help, in-plant seminars and specialized field service.

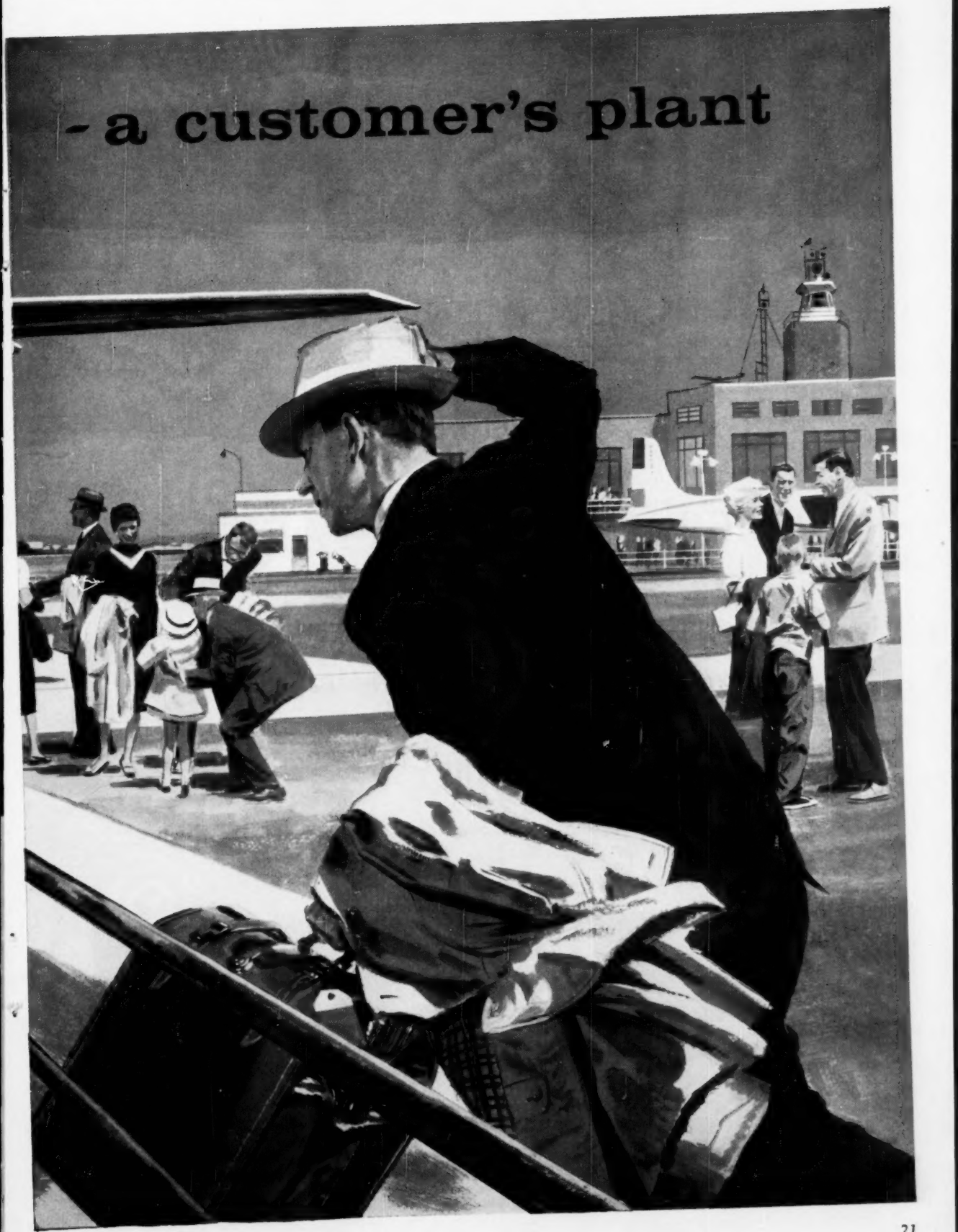
What's behind the Glascote sales engineer . . . and his glass-lined products? He's an experienced engineer who can give you on-the-spot product and process assistance. And behind him—38 years of Glascote experience in manufacturing glass-lined vessels and tanks for the process industries. Through continual research and development engineering, Glascote stays ahead of the demand for new and improved processes requiring a wider range of corrosion, temperature and thermal shock-resisting properties for glass linings.

Custom and Standard Reactors — Designs include the HR (Heavy-duty closed), CR (clamp-top), SR (standard closed) and the new spherical reactor. Capacities range from 300 to 8,000 gallons dependent on design.

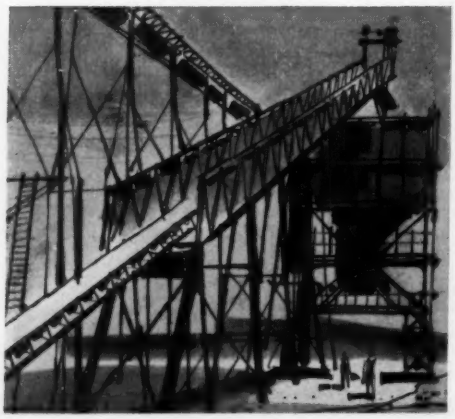
Glascote®
PRODUCTS, INC.
CLEVELAND 17, OHIO

Sales offices or agents in principal cities. Export sales: A. O. Smith International S. A., Milwaukee 1, Wisconsin, U. S. A.

A SUBSIDIARY OF **A. O. Smith** CORPORATION
World's largest manufacturer of glass-protected steel products


-a customer's plant

Wherever you use rubber products of neoprene or HYPALON® you cut costs



Conveyor belts of neoprene or HYPALON often keep rolling twice as long as ordinary belts, even though exposed to chemicals and hot materials which quickly destroy ordinary rubber.

Acid hose gives longer service when it is lined with HYPALON for strong oxidizing chemicals or with neoprene for other chemicals. As covers, both resist wear and weather.

You get longer service life . . . reduced maintenance costs . . . and less downtime. In chemical applications, there's a double benefit in the unique properties of Du Pont neoprene and HYPALON. Whether they are used in acid hose, conveyor belting, gasketing, tank lining or safety clothing, they do a better job *and* cut costs while they are doing it.

Results speak for themselves. Neoprene lining in a hot acid fumes scrubber stopped costly shutdowns during the production of critical lithium hydroxide and carbonate. In soda ash storage tanks, submerged neoprene check valves, exposed to 265°F. steam, have been used since 1955 with practically no maintenance. Neoprene—offering resistance to oil, grease, abrasion and flexing—is capable of withstanding more deteriorating influences than any other rubber.

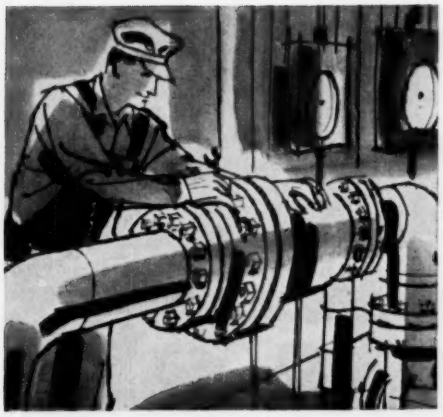
HYPALON, a new Du Pont synthetic rubber, gives products still greater resistance in specialized conditions. For instance, HYPALON seals on an acid fume condenser have been exposed to Aqua Regia, chlorine, nitric oxide, nitrogen dioxide, and nitrogen tetroxide since 1956 without signs of deterioration. HYPALON also has excellent resistance to ozone, oxidation-aging, abrasion and high temperatures.

Rubber products which offer you the longer-term economy of neoprene and HYPALON are available through your local rubber goods distributor. He can suggest the right product for your applications and offer quick delivery on small or large orders. Take advantage of his convenient service by calling him soon. For more information about the properties and many industrial uses of Du Pont neoprene and HYPALON, write for *Du Pont Elastomers in Industry* to: E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Dept. CE-10, Wilmington 98, Delaware.

Du Pont synthetic rubbers do more things better . . .
NEOPRENE • HYPALON®

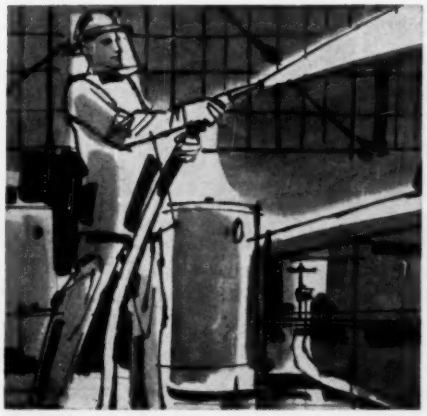
DU PONT
REG. U. S. PAT. OFF.

Better Things for Better Living . . . *through Chemistry*

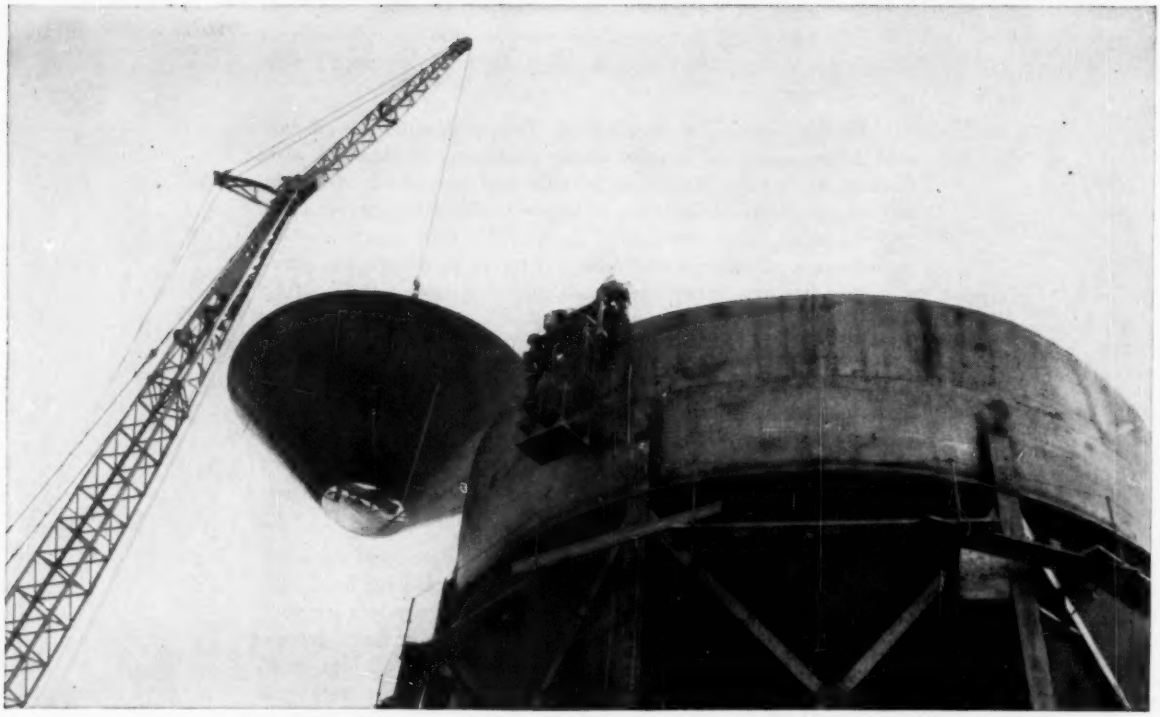


Gasketing of Du Pont neoprene and HYPALON resists chemical attack and compression set . . . keeping joints tighter longer. Under extreme conditions it holds up where others fail.

Neoprene safety clothing allows freedom of movement while giving the wearer long-lasting, positive protection against chemicals and acids, and even hot oils.



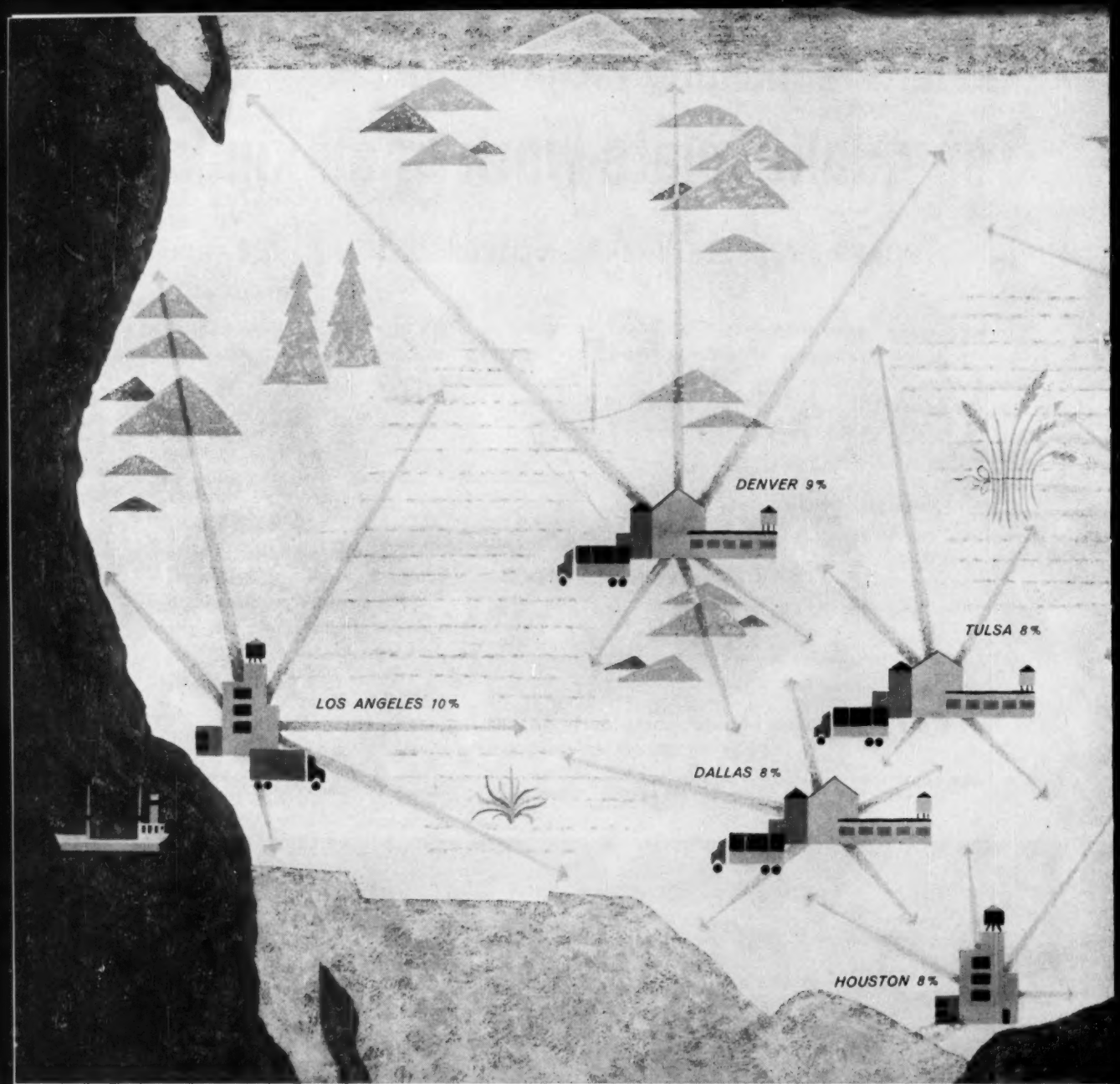
Ready now at Orange, Texas



You name it . . . we'll make it . . . and erect it too!

Anything American Bridge fabricates, it can also erect. Possessing the most complete range of construction equipment in the industry and skilled personnel backed by over 50 years of experience, we can handle any plate job anywhere. American Bridge has no peer in the specialized business of steel construction.

BIG EQUIPMENT for important jobs. The modernized plate fabricating shop is a two-aisle building, 177′ wide and 750′ long, with extended crane runways, 270′ and 200′ lengths at either end. The heavy aisle is furnished with two 50-ton, one 15-ton and one 10-ton crane and the light aisle has one 25-ton, one 15-ton and one 10-ton crane.



NEW SAVINGS ON

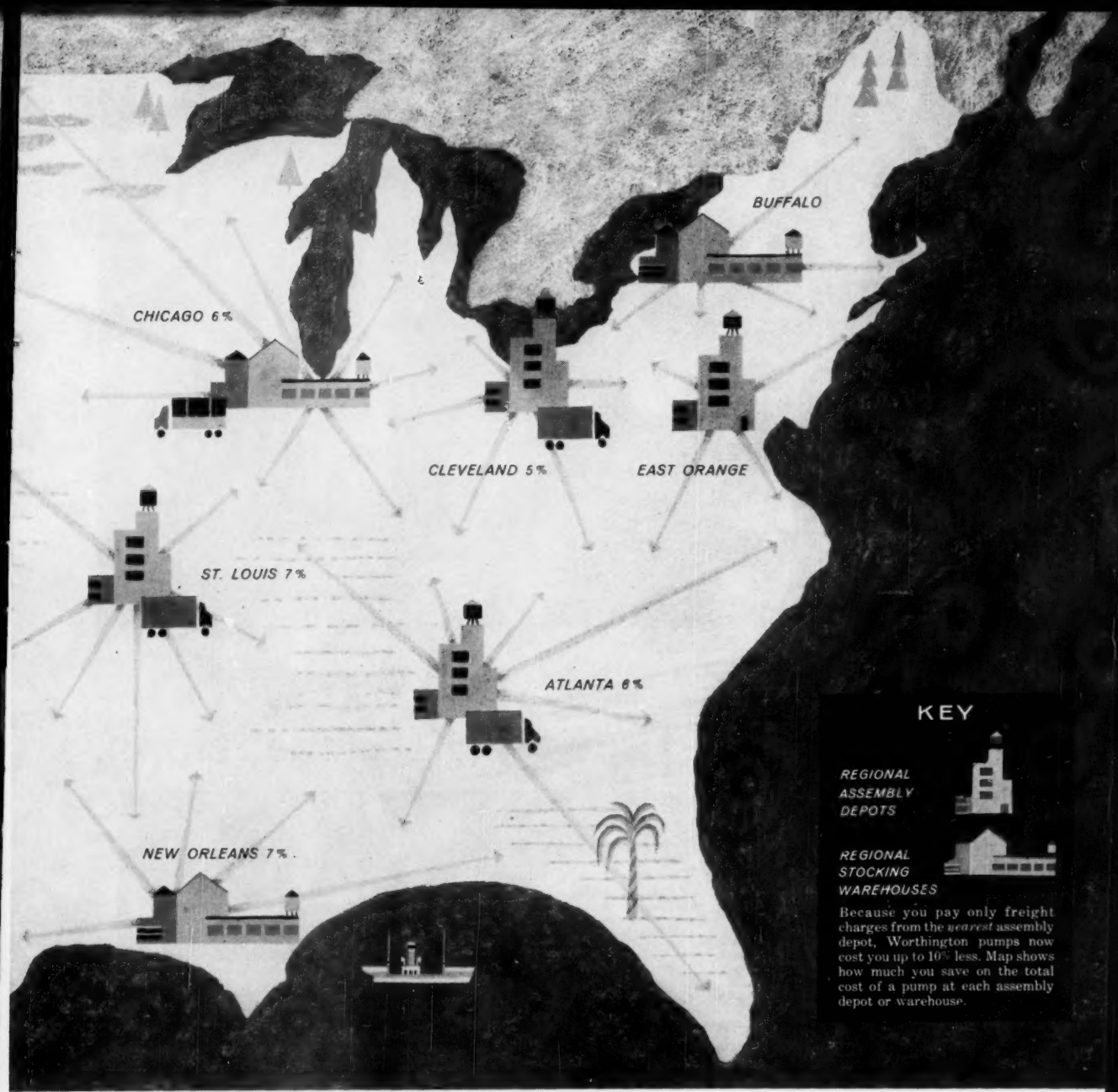
Look at the map to see how much *less* you pay!

Refer to Chemical Engineering Catalog for Detailed Description of Worthington Standard Pumps

Worthington has reduced the cost of SESC pumps by spanning the nation with *new regional assembly depots.* In addition to the primary depot in East Orange, (N.J.), others have been established in Cleveland, Atlanta, St. Louis, Houston and Los Angeles. Worthington can now pass along savings to you in three ways. One, on the price: as much as 10% depending upon your location. Two, on time—because your order can be processed and shipped in a matter of hours. Three, on parts service—because each of the assembly depots maintains a stock of spare parts.

In addition to assembly points, Worthington also maintains stocks of completely built pumps in Buffalo, Chicago, Denver, New Orleans, Dallas and Tulsa.

But there are other reasons why SESC (standard end



WORTHINGTON PUMPS

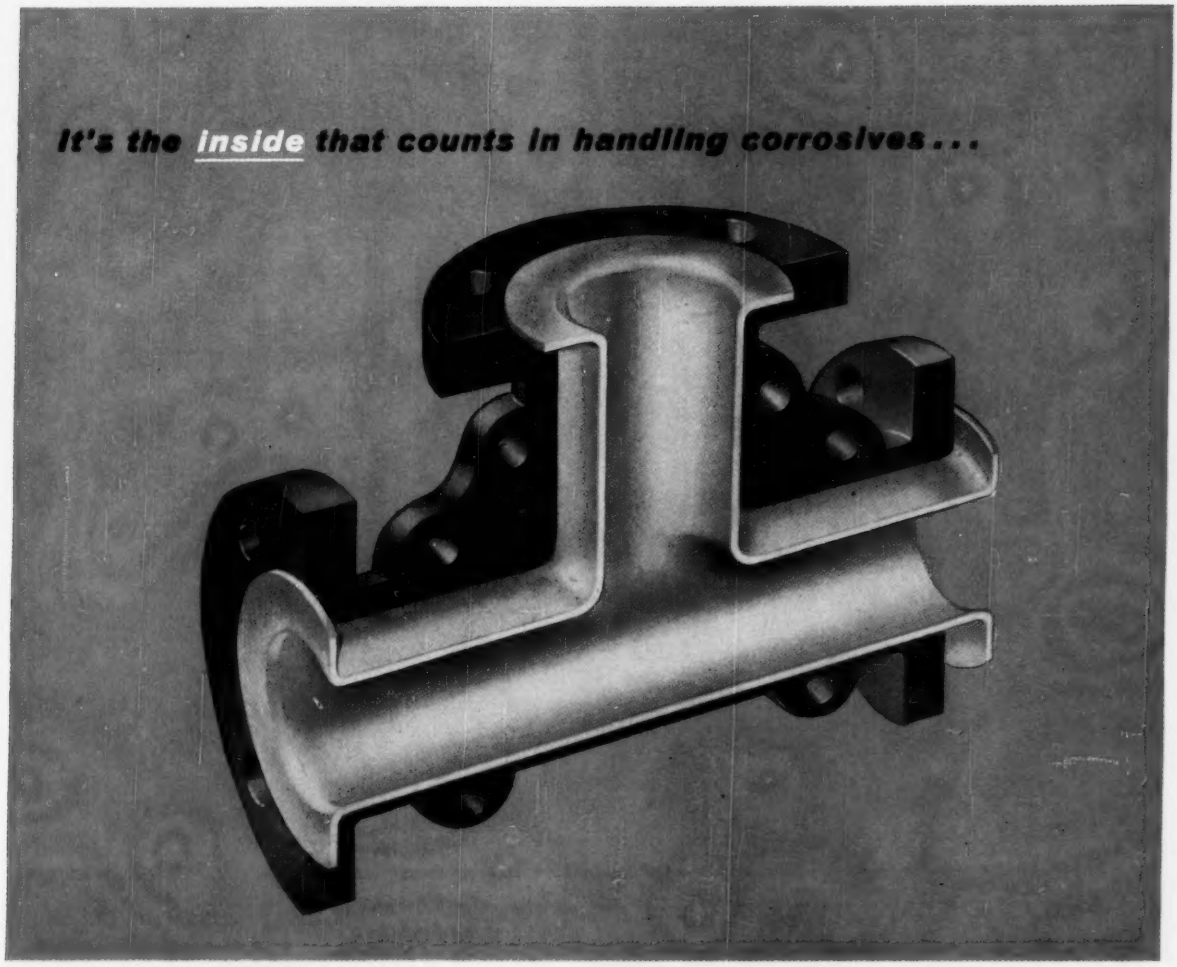
suction centrifugal) is far and away your best pump buy. Standardization gives you a high degree of interchangeability. Pumps may be all iron, all bronze, standard fitted, or Worthite*. 120 different sizes, with open or closed impellers are available with capacities up to 2700 GPM and heads to 550 Ft. Conventionally packed boxes or mechanical seals are optional in all pumps, and conversions from packed boxes to seals may be made on units in the field. All in all there are 70,480 modifications of the SESC pump to choose from—the broadest combination the pump industry has to offer.

SESC pumps also give you these benefits of standardization. You can cut your spare parts inventory by 50% because only four bearing frame sizes are used for the entire 120-pump line, and all pump parts are interchangeable. This means reduced downtime if repair or conversion is made. Finally, one basic design for the complete line simplifies maintenance and lowers overall operating costs.

Take advantage of the new low costs—the speeded delivery—the many outstanding features of the Worthington SESC line now. For detailed information, write for Bulletin W-300-B-4-B. Worthington Corporation, Section 20-3, Harrison, New Jersey. In Canada: Worthington, Ltd., Brantford, Ontario.

*Worthite is a high nickel, high-chromium, low-carbon alloy steel. Trademark Reg. U. S. Pat. Off.

WORTHINGTON



Protect against costly breakdowns by using pipe lined with a TFE-fluorocarbon resin

In handling corrosive materials, maintenance can be a major problem. A single shutdown for pipe repair can cost you more than an entire piping installation. In corrosive services, the only pipe worth using is pipe you don't have to replace . . . pipe lined with a TEFLON TFE-fluorocarbon resin. This pipe is unaffected by the most powerful acids, bases, and solvents.

For example, pipe lined with a TFE-fluorocarbon resin replaced stainless steel pipe in a process stream containing sulfuric acid, sulfur, and sodium sulfate in water, under pressure, at a temperature of more than 240°F. Corrosion was eliminated, and, with it, the possibility of contamination with metal ions, which can often act as catalysts. The non-adhesive surface of the liner prevents plugging by the high viscosity material.

TFE-fluorocarbon pipe lining has many other advantages. It won't shatter under vibration or thermal or physical shock, like brittle liners. It can be used at temperatures up to 500°F. The liner flared over the flanges provides complete protection for the steel from the process fluid and eliminates the need for additional gasketing. And now you can get a complete assortment of standard sizes of flanged pipe and fittings, including tees, elbows, and reducers, all lined with Du Pont TEFLON TFE resin.

To minimize maintenance and downtime in chemical services, install pipe lined with TEFLON TFE resins. Check with your local supplier for details, or, for more information, write to: **E. I. du Pont de Nemours & Co., (Inc.) Polychemicals Department, Room 710, Du Pont Building, Wilmington 98, Delaware.**

IN CANADA: Du Pont Company of Canada (1956) Limited, P. O. Box 660, Montreal, Quebec.

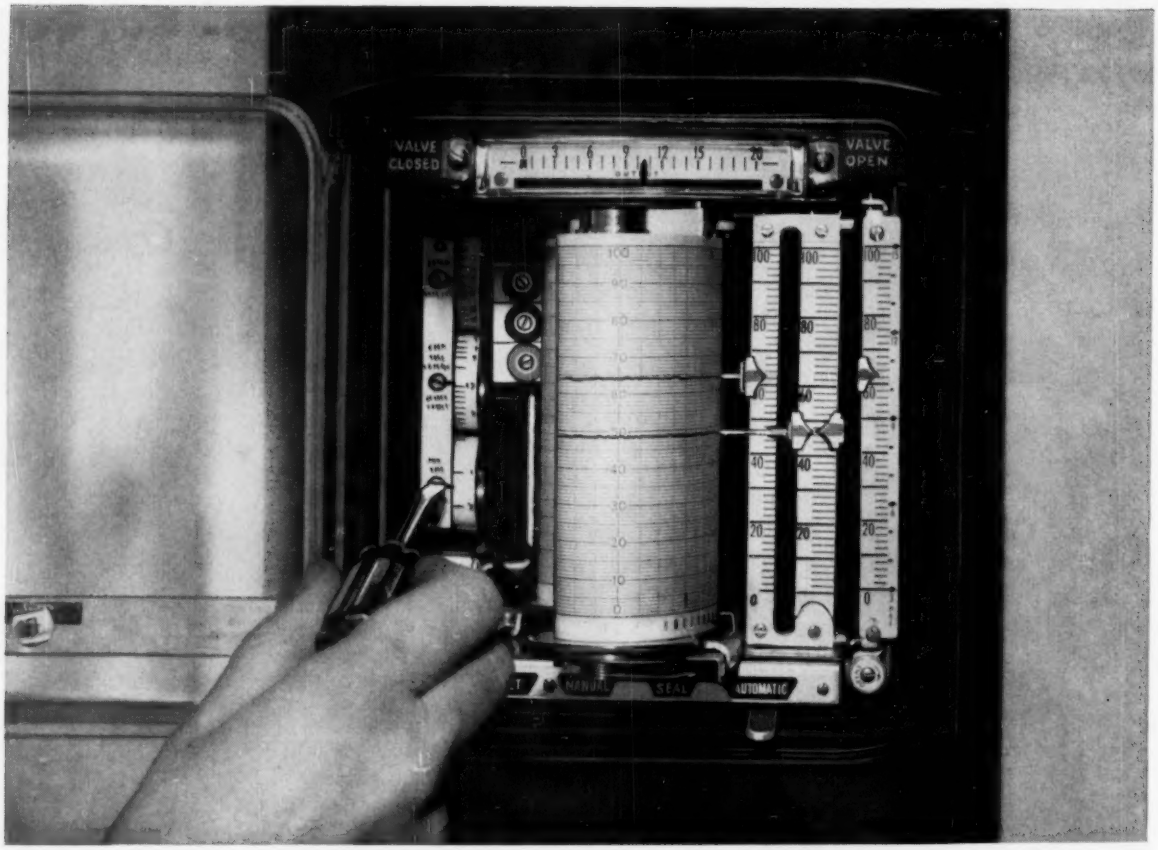
DU PONT ®REG. U.S. PAT. OFF.

TEFLON®

TFE-FLUOROCARBON RESINS

TEFLON is Du Pont's registered trademark for its fluorocarbon resins, including the TFE (tetrafluoroethylene) resins discussed herein.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*



WHY USERS ARE STANDARDIZING ON THE TAYLOR TRANSCOPE* RECORDER

Never before so many features in so little panel space!

1 All settings and adjustments made from front. Results are immediately obvious and the record is uninterrupted. Control response adjustments —when a TRANSCOPE Controller is mounted on the rear of the recorder—can be made with a screwdriver *without going behind the panel board.* Gain, reset and PRE-ACT* dials are calibrated in specific units.

This elimination of 'blind adjustments' is typical of the attention to detail that has gone into the design of the 90J series Recorders.

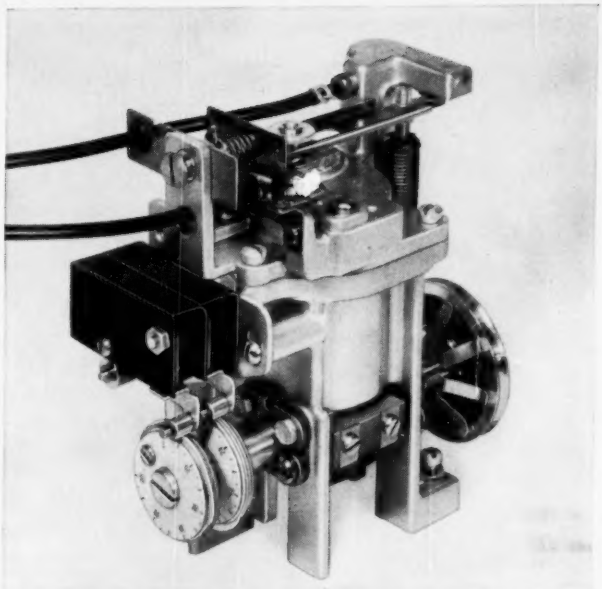
Also color-coded, adjustable signal-dampers (one for each recorded variable) are easy to get at, located right behind the chart drive.

2 Plug-in design. All principal assemblies are plug-in mounted for flexibility and easy accessibility. Individual unit parts are interchangeable.

3 Left-to-right record. 4″ rectilinear strip chart travels from right to left for easy reading. Gives continuous 30 day record (optional 24 hr.)—3 hour visibility. Most dependable chart drive ever devised—available in electric or pneumatic form. Pneumatic impulse twice as smooth as in conventional impulse drives.

4 Bumpless Automatic-to-Manual switching. Air leakage while switching is eliminated by an ingenious "O" ring slide valve. Selector lever travel is limited by mechanical stops, insuring positive positioning.

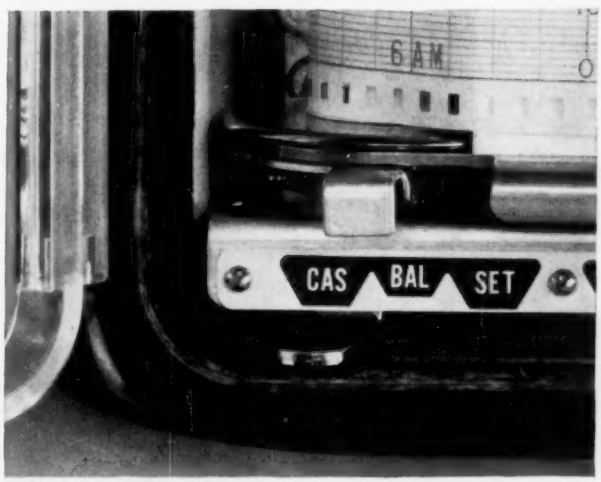
5 More accurate records. The Servomatic ▶ Motors give precise pen positioning. Essentially a power piston with a built-in positioner, the servomatic motor is the heart of the TRANSCOPE Recorder. Delivers 150 times more power than the conventional bellows type actuation, insure lifetime accuracy and sensitivity, a minimum of maintenance. *Servos are sensitive to changes of less than 0.1% in the pneumatic signal.*



6 Process Alarms provide built-in protection. ▶ As many as six process alarms can be incorporated in one recorder housing. Attached to the servo drive shaft, they may be either electric or pneumatic. Alarms are available in various combinations and may be set for high level, low level or band.

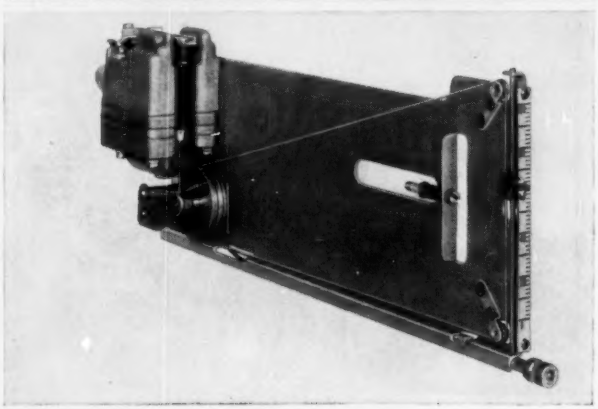
7 A Complete Cascade System in one case. ▶ The 90J Recorder was the first to incorporate a complete cascade system in one recorder case in a 6″ panel cut-out. It provides the simplest, smoothest process start-up. There are no external switches or relays. (Note unique Cascade-Balance-Set Switch.) Master and secondary variables are continuously recorded. Master and secondary controller outputs, as well as set points, are continuously indicated.

This outstanding feature of the 90J Recorder means substantial savings in instrument costs, panel space, operator's time.



8 Unique Set Point Transmitter allows continuous control. ▶ The 90J Recorder's Set Point Transmitter is a complete plug-in unit, separate from the main recording mechanism. Thus when the recorder slide is removed for checking the transmitter remains plugged into housing, keeping the process on uninterrupted, fully automatic control.

Thanks to this exclusive TRANSCOPE feature there's no need for process down time for instrument inspection or servicing.

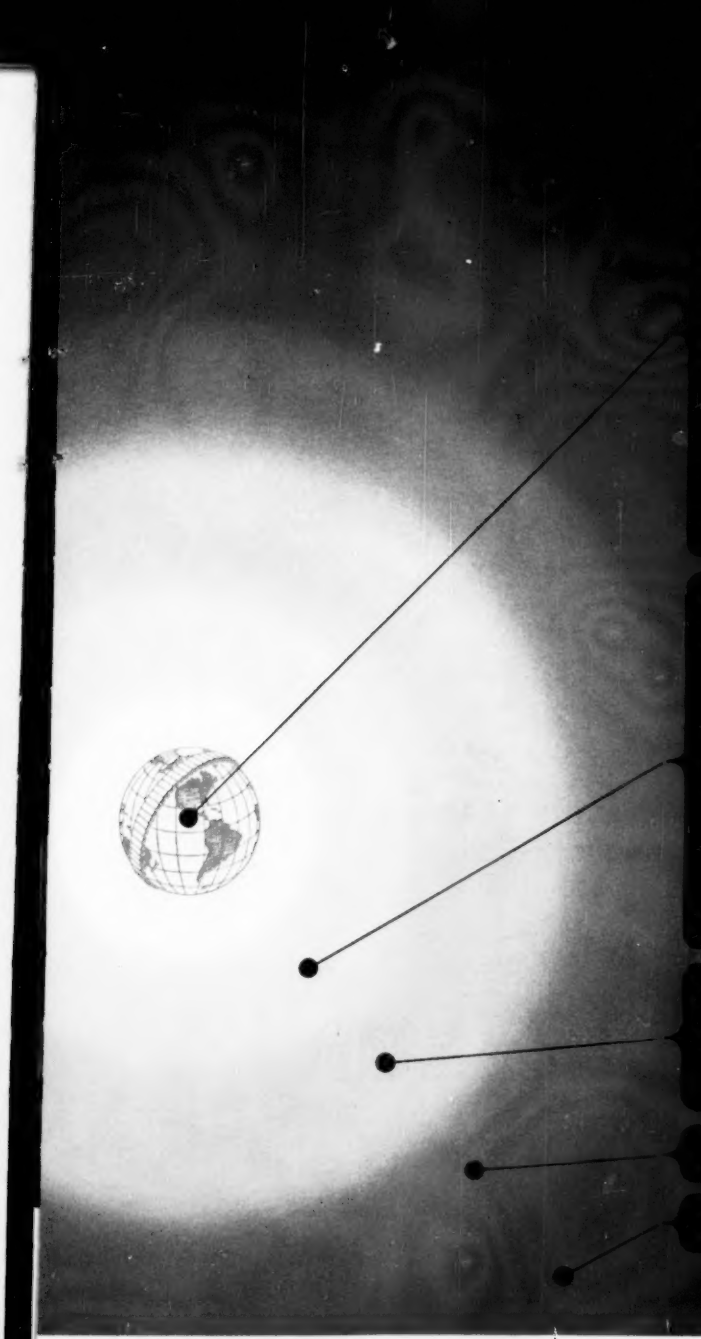


See your Taylor Field Engineer, or write for ***Catalog 98286***

Taylor Instrument Companies, Rochester, N. Y., or Toronto, Ontario

*Trade-Mark

Taylor Instruments MEAN ACCURACY FIRST



Approximate Service Limit	Brand
3200°F.	Castolast (Castable)
3100°F.	H-W High Alumina Castable
	Apache (Plastic Fire Brick)
3000°F.	Chromepak (Casting Mix)
	H-W Super Plastic Fire Brick
	Apache G (Plastic Fire Brick with Graphite added)
2900°F.	H-W Black Patch (Plastic Fire Brick)
2800°F.	Harcast (Castable)
2700°F.	H-W Super Castable
2600°F.	H-W Lightweight Castable 2600
	Harchrome (Castable)
	H-W Chrome Castable
2500°F.	H-W Standard Castable
	H-W Periklase Castable
	H-W Baffle Mix (Castable)
2400°F.	H-W Extra Strength Castable
2300°F.	H-W 85 Lightweight Castable
2200°F.	H-W 56 Low Iron Castable
	H-W 56 Lightweight Castable
1800°F.	H-W 25 Lightweight Castable
1500°F.	H-W Castable RC

The complete series of HARBISON-WALKER PLASTIC and CASTABLE REFRACTORIES

can assure the proper selection for maximum life and economy

In addition to the wide range of service temperature limits as here illustrated, these monolithic refractories possess the many different combinations of physical and chemical properties needed for best protection against widely diversified destructive factors. From these brands the best balanced selection can be made for adequately withstanding the most severe operating conditions. Some examples of the many destructive influences against which maximum resistance is needed, are: corrosion by slags, fuel ash and various other fluxes; thermal shock; disintegrating action of gases; erosion by molten metals and slags; mechanical stresses at the high working temperatures.

To help secure maximum service from these refractories, Harbison-Walker freely offers engineering service, recommendations based upon wide experience, and quality-controlled products.

HARBISON-WALKER REFRACTORIES CO.
AND SUBSIDIARIES GENERAL OFFICES: PITTSBURGH 22, PA.
World's Most Complete Refractories Service

TYPICAL FURNACE APPLICATIONS: ARCHES • ASH PITS • BOILER SETTINGS • BREECHINGS • BURNER BLOCKS • BAFFLES • CATALYTIC REACTORS • DOOR LININGS • DUCTS AND PIPING • HEARTHS • INSULATION • KILNS AND CARS • LADLE LININGS • ROTARY KILN CHAIN SECTIONS • SOAKING PIT COVERS

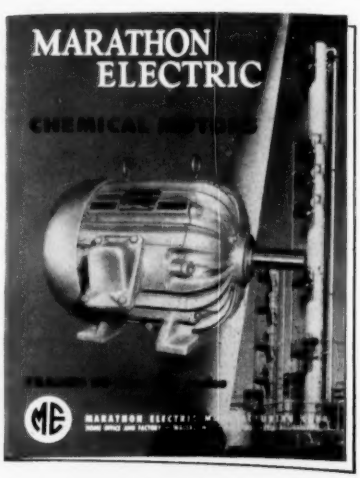
SPECIALLY BUILT

for all atmospheric and hazardous conditions

Depend on *ME* for designs that assure safe, long motor life despite corrosive elements in and about chemical plants. From a complete range of chemical and explosion-proof motors, Marathon quickly supplies your needs from a single motor to power-fitting an entire plant.

Free detailed information.

Marathon chemical motors incorporate the most recent features and improvements based on almost 50 years of motor building. For complete factual information, write for your copy of bulletin SB-185. *Marathon Electric Manufacturing Corporation, Wausau, Wisconsin.*



ME® *Motors and generators—that's our business!*

Motors from 1/20 HP to 3500 HP
Generators from 1/2 KW to 2500 KW

MARATHON ELECTRIC

Home Office and Factory, Wausau, Wis. • Factories At Erie, Pa. and Earlville, Ill. • Sales Offices in Principal Cities

LESS BOILER MAINTENANCE BECAUSE A LJUNGSTROM CUTS SLAGGING

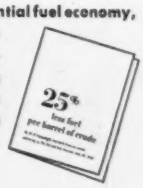
A Ljungstrom air preheater reduces slagging and cuts boiler downtime by boosting combustion air temperature, in some cases by as much as 1000°F. Whatever fuel you use, hotter combustion air makes it burn more cleanly and completely, with less slag and deposits.

More complete combustion also makes standard equipment work at top efficiency, producing more heat from less fuel. One east coast refinery saves $129,000 a year on their fuel bill through increased furnace efficiency. This increased efficiency contributes to an upgrading of the product by 1½ octane numbers, providing an additional annual profit of $58,000.

How fast is "WRITE-OFF"?

Savings like these — where equipment makes a better product . . . lasts longer . . . and costs less to maintain — can pay for a Ljungstrom air preheater *in as little as two years.* Or, if you use the higher combustion efficiency of a Ljungstrom-equipped furnace to increase throughput, write-off time can be cut to nine months!

For further information on potential fuel economy, write today for your copy of a factual article by O. F. Campbell describing one company's fuel savings with a Ljungstrom air preheater. Call or write The Air Preheater Corporation.



THE AIR PREHEATER CORPORATION

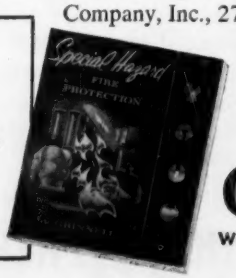
60 East 42nd Street, New York 17, N. Y.

Fairly commonplace in industry today are special hazard areas, where special protection must be provided to assure against possible serious loss by fire. Grinnell, with 88 years' experience protecting against fire hazards of every description, has the most effective extinguishing agents and best systems for each type of hazard.

Remember, too, the installation of the proper Grinnell System usually serves to reduce fire insurance premiums drastically, often pays for itself in a few years!

TABLE OF CONTENTS

- Recognizing Your Special Hazards
- The Fire Triangle in Special Hazard Fire Protection
- Special Hazard Fire Terms Defined
- Water Spray Systems
- Selfcon Water Spray Systems
- Foam Systems
- Carbon Dioxide Systems
- Dry Chemical Systems
- Control Equipment and Devices
- Quick Selector Chart
- Research and Testing
- Sales, Engineering, Installation and Inspection Service



FREE REFERENCE MANUAL! This new 44-page reference manual — "Special Hazard Fire Protection by Grinnell" — gives you a comprehensive picture of all the most advanced methods for Special Hazard fire protection. It includes explanations, applications, photographs, case histories of Grinnell systems and specialized equipment . . . and a Quick Selector Chart to help you determine the most effective system for your special fire hazard.

Write for your complimentary copy today. Grinnell Company, Inc., 277 West Exchange St., Providence, R. I.

GRINNELL

WHENEVER FIRE PROTECTION IS INVOLVED

Manufacturing, Engineering, and Installation of Fire Protection Systems since 1870

IN SRE... Zallea expansion joints absorb thermal expansion of reactor core tank and outer tank

The very nature of the Sodium Reactor Experiment, conducted by Atomics International for the AEC, and the method of handling the liquid sodium reactor coolant demand reliability in expansion joints. Because of the operation there can be no compromise in design or quality.

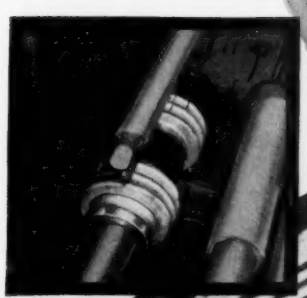
The high temperature SRE uses Zallea Expansion Joints where thermal expansion must be absorbed and where a gas seal must be maintained. An 11-ft. diameter Zallea Expansion Joint at the top of the outer tank absorbs the expansion that results from the temperature increase in these components as the reactor comes up to operating temperature, 960°F. In addition, the expansion joints form a seal for the helium gas and sodium vapor above the sodium pool at the top of the reactor as well as for the helium gas within the outer tank.

In the sodium coolant piping circuit gas seals are effected by means of Zallea Expansion Joints in the region where the pipes leave the reactor cavity and enter the pipe galleries.

Zallea has worked with almost every major engineering and manufacturing firm engaged in atomic, nuclear and missile work—and has provided the large majority of expansion joints for such projects. As a result, we have accumulated a store of expansion joint engineering data and manufacturing skills that cannot be equalled. Whenever expansion is involved in piping systems, reactors, tanks—whatever the application—let our engineers work with you. We already have the answer to many of the difficulties you will encounter. And we welcome the chance of tackling your problem.

Zallea
expansion joints

ZALLEA BROTHERS, Wilmington 99, Del. • World's largest manufacturer of expansion joints



WORLD'S FIRST COMMERCIAL SCALE SHELL PROCESS ETHYLENE OXIDE PLANT ON STREAM

Plant for Wyandotte Chemicals Corporation Reaches Capacity Within 2 Weeks of Start-up

The first commercial scale plant to use the Shell Development Company's direct oxidation process for making ethylene oxide is on stream for Wyandotte Chemicals Corporation at Geismar, La.

This is the first of three ethylene oxide plants being designed, engineered and constructed by The Lummus Company, each with an annual capacity equivalent to 60,000,000 lbs. of ethylene oxide.

Most of Wyandotte's oxide will be converted by thermal hydration to ethylene glycol for industrial and antifreeze uses.

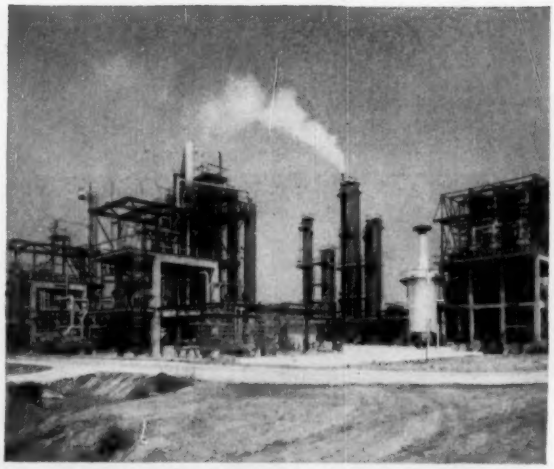
The process units at Wyandotte consist of an ethylene oxide reaction section, an ethylene oxide purification section, an ethylene glycol section and an oxygen generation section.

Non-process units provided by Lummus include: tankage and yard transfer facilities, cooling and fire-water system, an administration building, change and gate house, warehouse and shop building, and a garage and firehouse.

In the Shell Process for making ethylene oxide, ethylene is reacted with oxygen over a silver catalyst in a fixed bed reactor.

The Shell innovations which have been thoroughly tested in pilot plants offer several noteworthy advantages. Among these are high yields and virtual elimination of the waste disposal problems encountered in the chlorohydrin process. The plant uses oxygen, which requires less capital investment than the use of air.

The other two plants currently under construction by Lummus are for Calcasieu Chemical Corporation, at Lake Charles, La. and for Petrochemicals Ltd., one of the Royal Dutch Shell group of companies, at Partington, England. Both are scheduled to go on stream later this year.



Lummus is proud of the initial performance at Wyandotte in placing the Shell Process into full scale application. These ethylene oxide plants are 3 more of the over 800 plants designed, engineered and constructed by The Lummus Company throughout the world, in the last 50 years, for the process industries. Lummus is ready to place this experience at your disposal.

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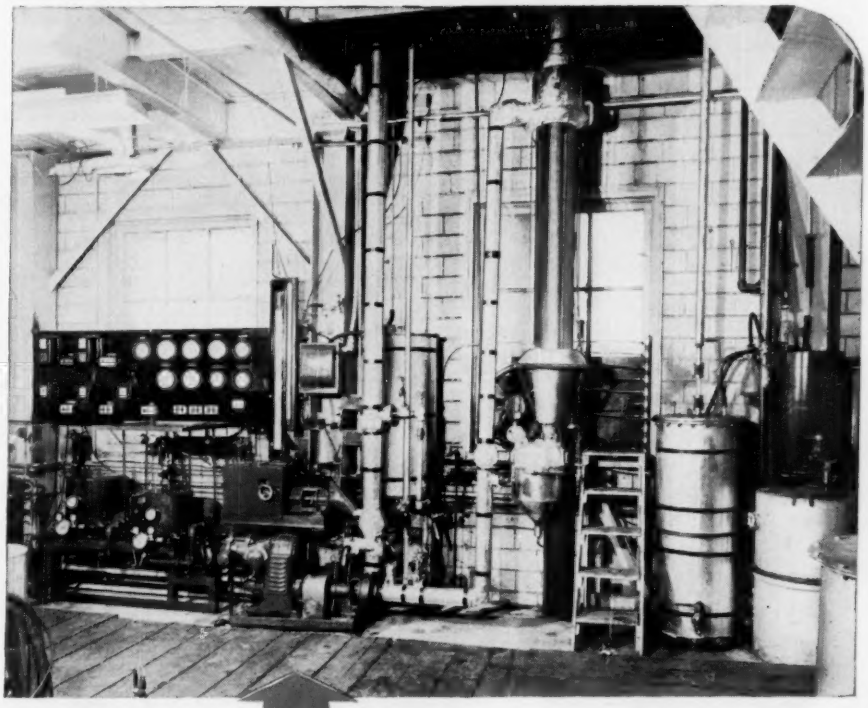

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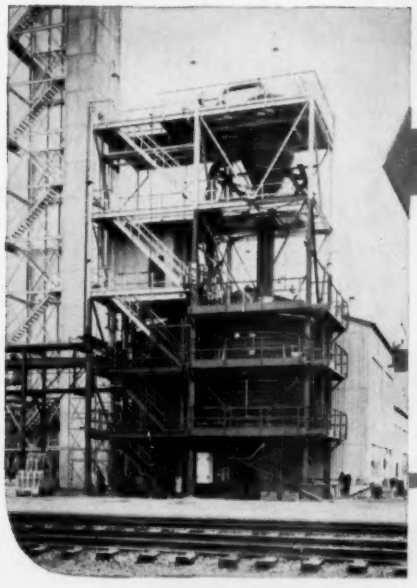

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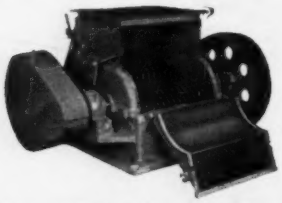
Published in the interest of better processing by Sprout, Waldron & Co., Inc., Muncy, Penna.

PHENOLIC STOCK REDUCED IN SAW TOOTH CRUSHER

The reduction of calendered sheeting for phenolic molding compounds is being accomplished in a single pass through a heavy duty Sprout-Waldron saw tooth crusher. The warm material comes to the crusher in strips 6″ to 9″ wide, 12″ to 18″ long and in a variety of thicknesses. It is reduced to approximately ½″ square pieces.

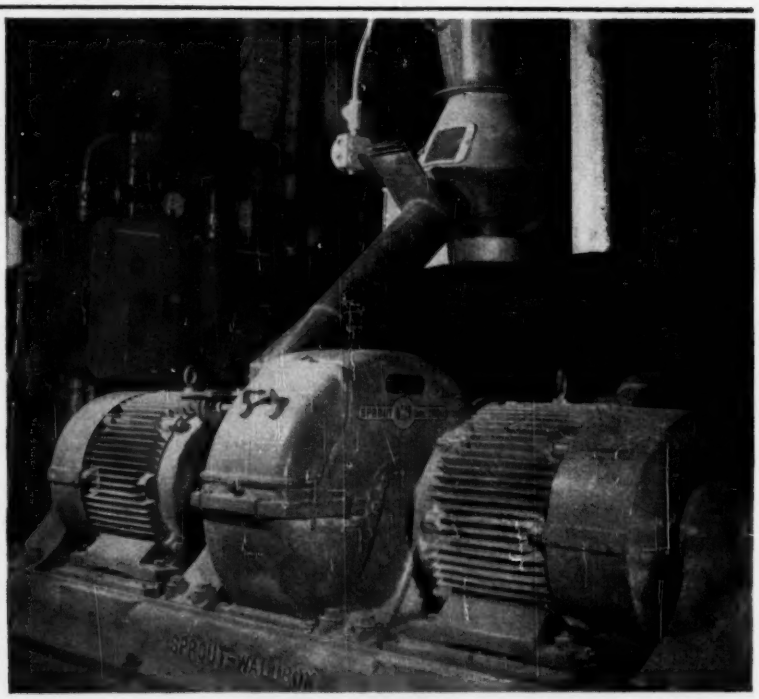
This precision-built heavy duty 16 x 25 Saw Tooth Crusher has been in successful operation at the General Electric Company plant in Pittsfield, Massachusetts for over 10,000 working hours, and it is still going strong. Its hard faced 16″ diameter breaker saws are designed specifically for the reduction of tough or brittle materials. In fact, everything about this crusher suggests high productivity under the most demanding conditions. Here are some of the key design points:



This Sprout-Waldron 16 x 25 Heavy Duty Saw Tooth Crusher has given more than 10,000 hours of satisfactory service in the crushing of phenolic stock at General Electric.

1. Precision-built.
2. Hinged covers to facilitate inspection or servicing.
3. Rugged construction. Alloy steel round shafts, mounted on large roller bearings.
4. Close fitting shrouds to prevent material by-passes.

For details, request Advance Specification Sheet No. 204.



STREAM SPLITTER KEEPS ATTRITION MILLS ON THE RUN

A few years ago the American Distilling Company installed a 26″ Sprout-Waldron double runner attrition mill for the grinding of corn, milo, rye, barley malt and other ingredients used in the production of Bourbon Supreme Whiskey, corn and rye whiskeys and grain neutral spirits. The mill discharged into a mechanical handling system consisting of a screw conveyor and bucket elevator.

As the need for expansion became obvious it was decided to install an identical Sprout-Waldron attrition mill to operate in parallel with the existing machine, providing greater flow rate, reduced wear and simplified maintenance.

The key to the new system is a Sprout-Waldron Model VA-5 stream splitter with two outlets which divides the flow equally between the two attrition mills. Four whole grain storage bins discharge to a common Sprout-Waldron 12″ x 18′ screw conveyor. The center outlet of the conveyor allows the grain to pass over a magnetic separator on the way to the stream splitter. As the ground grain emerges from the attrition mills it is conveyed to the roof of the building by a Sprout-Waldron 50 hp 44″ Pneu-Vac negative pressure system to another ground grain storage bin where it is held for further processing into quality whiskeys. For the facts on the Sprout-Waldron line of precision stream splitters, ask for Bulletin 137-B.

CP/106

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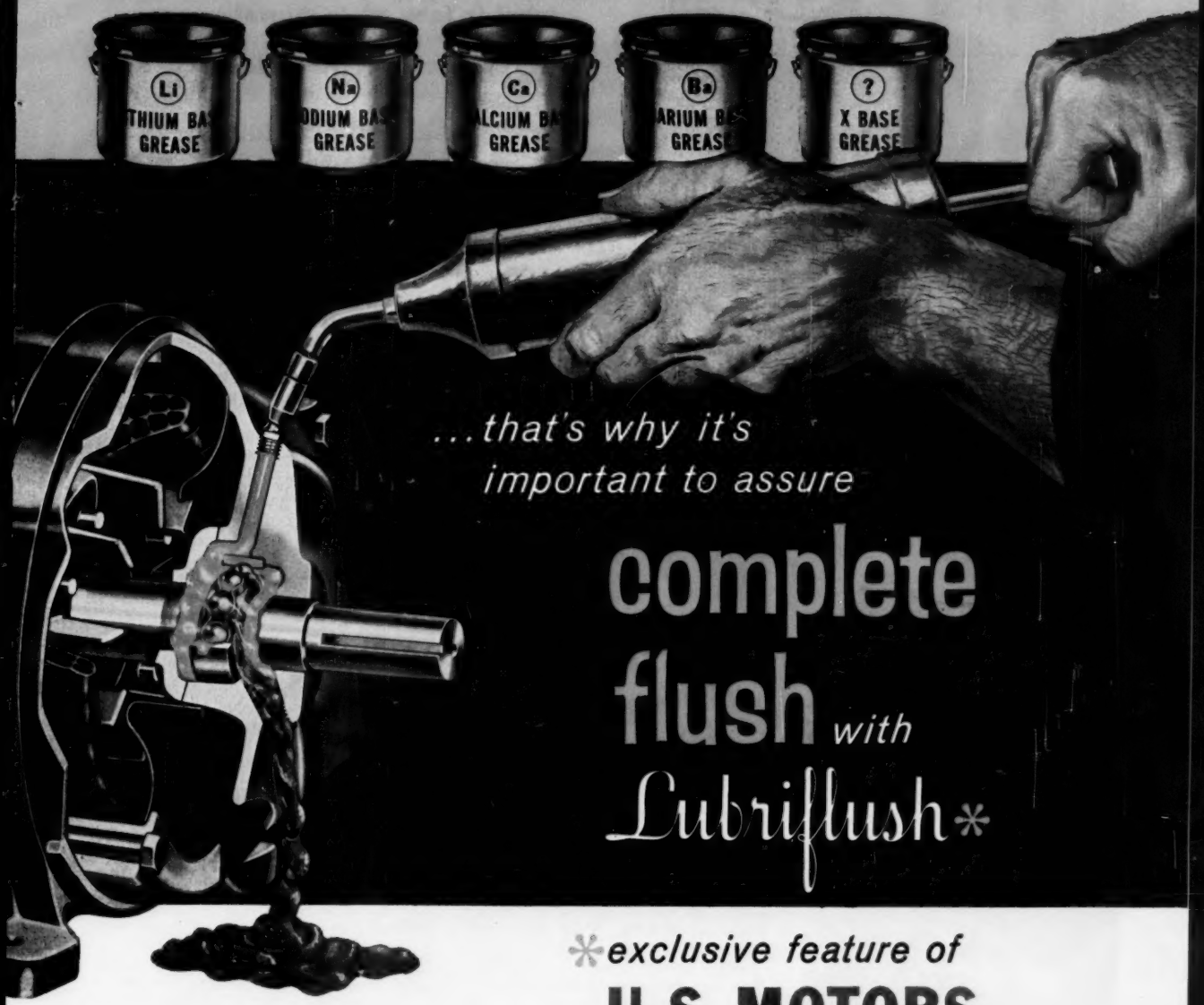

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BRIEFS

on chlorination and sulfonation...

what to look for in muriatic specs...

a free booklet on trichlorethylene

Selective chlorination and sulfonation

It's easy to do some profitable processing tricks with Hooker sulfuryl chloride.

A simple change in temperature or in catalysts or in the proportion of reactants you use can have profound effects on the end product.

React sulfuryl chloride with the sodium salts of organic acids, for example, and you can vary the process to produce either the acid chlorides or anhydrides.

You can use sulfuryl chloride to chlorinate and sulfonate both the aromatic compounds and the aliphatic hydrocarbons and their derivatives.

What else recommends our product? It's 99% pure. It gives off much less heat during chlorination than elemental chlorine. You need relatively simple and inexpensive equipment to work with it. It has no flash or fire point.

For the rest of the story, we suggest you send the coupon for a technical data sheet and copies of Bulletin 330, *Sulfuryl Chloride in Organic Chemistry*, and Bulletin 328A, *Chlorinating Agents*. This last also gives information on our other chlorinating agents, chlorine, sulfur chlorides, thionyl chloride, muriatic acid, etc.

What to look for in muriatic acid specs

This white gummy substance is an insoluble precipitate which can form in certain reactions with muriatic acid that contains too much sulfate.

Iron, arsenic, and free chlorine can also give a process indigestion when their level in a muriatic acid is too high.

So it pays to consider these carefully when you examine any muriatic's specs.

Take Hooker White Grade muriatic, for example. Iron: a mere 0.0001% at the most. Sulfates: less than 0.003%. Free chlorine: none. Arsenic: none.

Very often your process can stand a little higher level on these impurities. Hooker Commercial Grade offers these maximum specs: Iron: a low 0.0005%. Sulfates: 0.003%. Free chlorine: a slight trace. Arsenic: none.

Both grades come in rubber-lined tank cars. Both come in three strengths: 18°, 20°, and 22° Baumé. For more technical data, check coupon.

Free booklet on trichlorethylene

Here, in forty pages, is a wealth of material on trichlorethylene. Includes physical and chemical properties, shipping containers, handling methods, etc.

It gives complete data on all three grades of Nialk® trichlorethylene which are of interest to chemical processors:

Technical Grade Maximum acidity as HCl is 0.0005%. Alkalinity as NaOH is 0.001% at the most. This grade boils at 86.6 to 87.8°C under atmospheric pressure. On evaporation at 100°C the maximum residue is 0.005%.

Technical grade is often used as a freezing point depressant, particularly in carbon tetrachloride fire extinguishers and as a solvent in various adhesive formulations.

Extraction Grade No HCl acidity. NaOH alkalinity runs from 0.006 to 0.008%. This grade will boil between 86.6 and 87.4°C under atmospheric pressure. Used mostly for extracting fats from animal matter, and oil from raw wool, cottonseed, and flaxseed.

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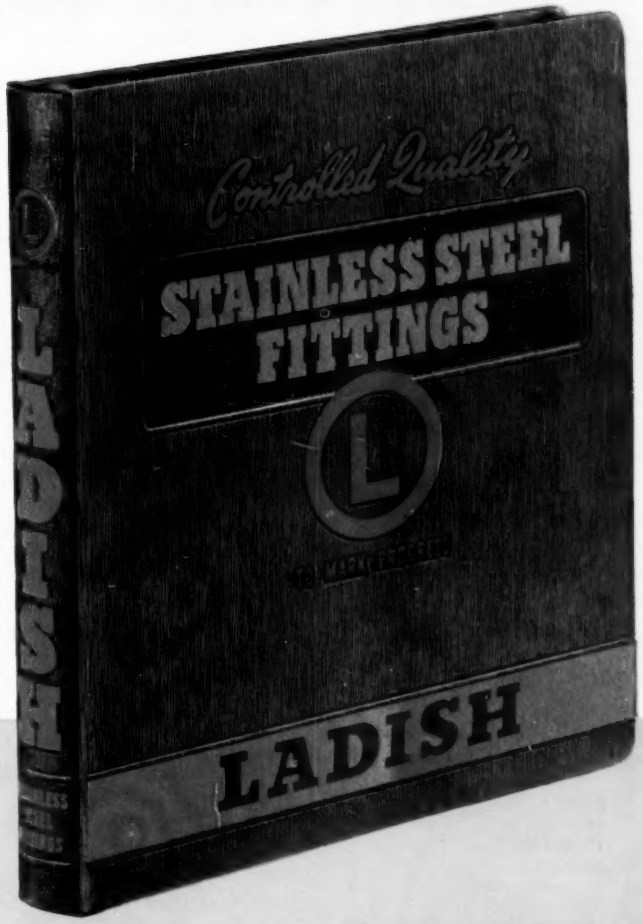

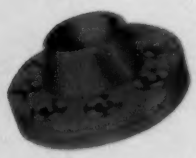

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CE

How to beat the high cost of temperature control

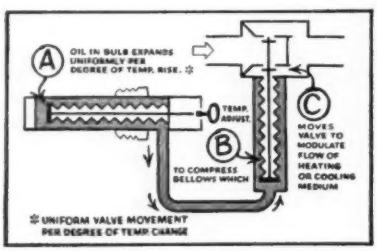
The practical approach to temperature control

By John W. Ritter, Test Engineer, SARCO Company, Inc.

Precise temperature regulation is essential in many processing operations, not only for quality control, but for maintenance of output as well.

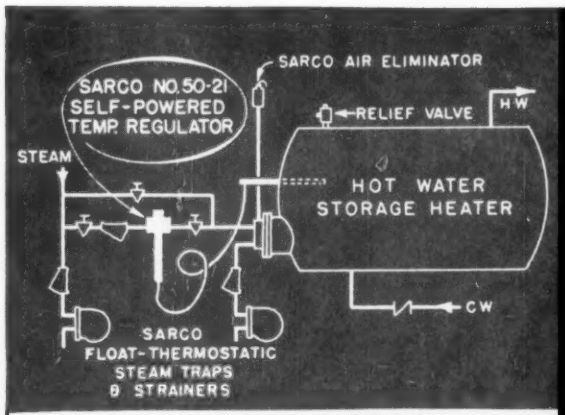
Manual temperature control is unsatisfactory because of the possibility of spoilage and loss of quality control which can result from irregular or indifferent hand regulation.

Automatic controls are available in a wide variety, including pneumatic, electronic, and self-powered. Pneumatic and electronic controls are relatively expensive to purchase and install, and may require frequent maintenance. However, in most applications, control requirements can be achieved very successfully by the use of relatively simple, economical Sarco Self-powered Regulators.



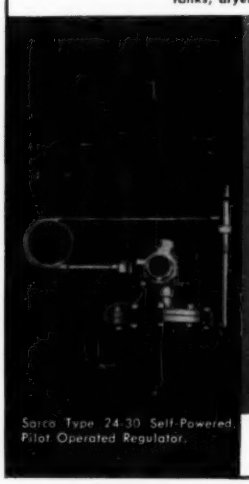
This drawing shows simplicity of operation of the Sarco 50-21 Temperature Regulator, which consists of a thermostat, capillary tubing, and a valve.

Sarco controls, like the 50-21 and the 24-30, have the required degree of sensitivity and dependability, combined with the ruggedness inherent in the sealed capillary tube construction. Because these Sarco controls do not depend on external power, such as electricity or compressed air, they have established long records of sustained, reliable operation. They are an economical and practical solution to the problem of maintaining continuous watchdog duty over processing temperatures.

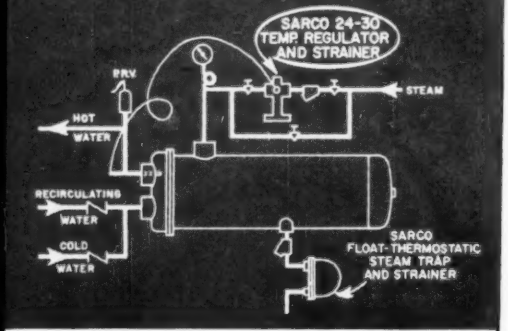


Typical applications: hot water storage heaters, shell and tube heat exchangers, condensers, oil storage tanks, dryers, kilns, etc.

Sarco Type 50-21 Self-Powered Regulator.



Sarco Type 24-30 Self-Powered Pilot Operated Regulator.



Typical applications: instantaneous heaters, fuel oil preheaters, and all dead-end service applications.

Self-powered automatic temperature regulators by SARCO . . .

have these 5 marked advantages: No compressed air or electrical wiring required. No delicate mechanisms to adjust or maintain. No packing glands to stick or require maintenance. No shutdown during power failure. No specialized maintenance required.

Sarco Self-Powered Controls are self-contained and can be installed by any pipe fitter. They are so reasonable in cost that you can afford Sarco automatic heating controls for every application in your plant. Write for 10-page Sarco Control Bulletin No. 620.

6346-B

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DEVELOPMENTS . . .

OCTOBER 6, 1958

Chementator

C. H. CHILTON

New iodine process is now on stream for Dow at Inglewood, Calif. Process uses ion exchange to recover iodine from oil-well brines.

Conveyor system carrying 1,000 tons/hr. of quarried rock over a distance of 5½ mi. to Ideal Cement Co.'s plant at Ada, Okla., will include world's longest individual span, says Link-Belt Co. Longest of seven spans will cover 11,920 ft., using a single 36-in.-wide rubber belt more than 4½ mi. long.

Several U. S. firms are dickering with Knapsack-Griesheim for use of the Hoechst subsidiary's new acrylonitrile process. The German process reacts HCN with acetaldehyde instead of acetylene, is said to get 10-15% better yields.

Rich air stimulates catalytic cracker

Oxygen enrichment of regeneration air has been shown in plant-scale tests this summer to permit a 15% increase in capacity of a nine-year-old fluid catalytic cracking unit.

Tests were conducted jointly by Linde Co. and Cities Service Oil Co. on a 22,500-bbl./day cat cracker at Cities Service's East Chicago refinery over a five-day period. Most of the test data were collected while using an oxygen enrichment rate of 100 tons/day, giving a final oxygen content in the regeneration air of 25.4%.

Optimum degree of air enrichment can't be determined exactly on the basis of this test, says Cities Service. However, the refinery is satisfied with test results so far and is going to continue testing for further evaluations.

A Cities Service spokesman told *CE* that other advantages of oxygen enrichment, in addition to greater regeneration capacity, might make it attractive even in new cracking units. For example, coke burning, which is ordinarily touchy, can be controlled better when using enriched air.

Oxygen for the tests came via liquid-carrying truck from Linde's East Chicago oxygen plant.

(For a description of a modern cat cracker using conventional air regeneration, see Process Flowsheet, pp. 120-123, this issue.)

New device sprays solventless epoxies

Spray application of solvent-free epoxy resin formulations is now possible with equipment being developed by Hodges Chemicals Co., Redwood City, Calif. The new machine "can accurately proportion the solventless resin with catalyst and produce a continuous film," asserts President Bill Hodges.

Right now, Hodges is doing spray application work only in the local West Coast area. Ultimate plans—still some months from realization—are to license the machine widely and

(Continued on page 45)

NEW THREADED-JOINT NEOPRENE-SEALED Control and Indicating Stations

Explosion-proof, dust-ignition-proof, weather resistant and water-tight (NEMA 4), this new Condulet® EWC series affords safety greater than ever before for pilot lights, heavy-duty push-button stations, selector switches, or various combinations thereof in single, double or triple gangs.

Designed expressly for Class I (Groups C and D) and Class II hazardous areas, the new series features a Feraloy® housing with *threaded* cover and *threaded* operating-shafts throughout. Cover, shaft housing and pilot light jewels are tightly sealed with Neoprene O-rings, effectively shutting out fumes, dusts, all water.

Write direct for descriptive literature and specifications, or contact your Crouse-Hinds distributor

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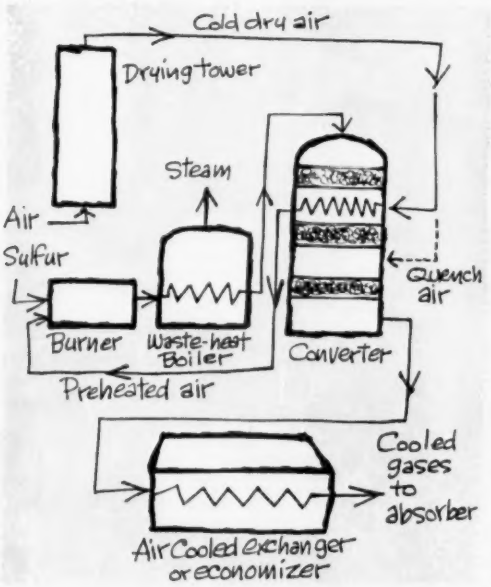
These products are sold exclusively through electrical distributors. For application engineering help, contact one of the following offices: Baton Rouge Birmingham Boston Buffalo Chicago Cincinnati Cleveland Corpus Christi Dallas Denver Detroit Houston Indianapolis Kansas City Los Angeles Milwaukee New Orleans New York Omaha Philadelphia Pittsburgh Portland, Ore. Salt Lake City St. Louis St. Paul San Francisco Seattle Tulsa Washington **Resident Representatives:** Albany Atlanta Baltimore Charlotte Chattanooga Jacksonville Reading, Pa. Richmond, Va.

to provide licensees with proper formulations for specific jobs.

Thickness of coating depends on service conditions. For example, on concrete floors, Hodges applies a wear-resistant epoxy coating 30-50 mils thick; chemically resistant epoxy tank linings are on the order of 10-20 mils.

Advantages of solvent-free application: Reduced fire hazard during application; elimination of the pinholing sometimes caused by solvent release; thicker coatings per pass of spray gun, permitted by high (100%) solids content.

New look in small sulfuric acid plants



As much as 20% reduction in cost of moderate-size contact-process sulfuric acid plants is claimed by D. M. Weatherly Co., Atlanta engineering firm with a successful record in building fertilizer plants (*Chem. Eng.*, Aug. 1956, pp. 128-132).

Weatherly compares its price of $350,000 for a typical 100-ton/day acid plant with an estimated $450,000 for a conventional plant built by old-line engineering firms.

Part of the lower cost is due to the novel system of heat transfer shown in the flowsheet. Weatherly uses cold air, instead of hot combustion gases, for removing heat from converter gases. The much greater available temperature difference results in a two-thirds reduction in required heat-transfer surface. Along with other changes in drying and absorption, the new flowsheet permits a simple plant layout, with further savings in cost.

Weatherly got into the acid plant business last year by building a conventional 80-ton contact unit for Southwestern Agrochemical Corp., Chandler, Ariz. Two potential customers for the new flowsheet are now on the string.

Joint approach to pollution problems

Chemical producers along the Houston Ship Channel—some 15 of them—are studying a proposal for a jointly supported pipeline and plant which would treat all their process wastes. Such a measure would get the companies off the hook with local and federal authorities who are bringing court action against some of them accused of water pollution.

Idea is being pushed by Fish Service Corp., Houston engineering firm. Fish would build the pipeline and disposal plant. Plant would be operated by a private concern, with operating costs charged to the chemical producers on a volume basis. To finance construction costs, the operating company might put up one-third of the equity, and the chemical companies would cover the other two-thirds.

Initial plant capacity would be 20,000 gpm. of wastes. Any and all effluents containing not more than 30% by volume of suspended solids will be handled. Processes being considered include flotation, aeration, sedimentation and chemical flocculation. No chemical recovery is planned.

While the project right now is concerned only with chemical producers, it is not necessarily limited to chemical plant wastes. However, no sanitary sewage will be accepted.

Advantages of joint disposal are readily apparent. One large treatment plant would be cheaper to build and operate than many individual small units. And the over-all treatment job would no doubt be easier because of the beneficial effects of combining dissimilar waste streams.

Copper: Next big "chemical" metal

Chemetals Corp.'s process for chemically converting copper scrap to powder is poised on the threshold of a doorway which could open up a new field of chemical metallurgy.

(Continued on page 48)

Heat Exchangers Last Longer...

up to 7 times longer for Union Oil

Union Oil Company of California is converting several of its shell and tube heat exchangers—and parts of these exchangers—to Reynolds Aluminum. Main reason: aluminum lasts longer in many heat exchanger applications, up to 7 times longer.

For example, in Union's heat exchangers which handle waste water from a refinery cat tower, steel condenser tubes lasted only a few weeks before corrosion made them useless. Aluminum tubes, now in the same service, last 7 times as long handling the same corrosive fluids.

In the same application, steel tube sheet and baffles lasted about 5 months before they had to be replaced. Union engineers replaced these with aluminum and installed aluminum bundles in January, 1957. They are still in service.

The bare tubes of Union's heat exchangers are Reynolds Aluminum alloy 3003-H14, and the tube sheets and baffles are 6061-T6.

Union Oil's aluminum heat exchangers really save in service cost. On a dollars per square foot of heat transfer area per year base, aluminum units are nearly *5 times lower in cost* than the same units with seamless mild steel. This does not include handling costs, which favor lightweight aluminum.

Initial cost, incidentally, is virtually the same for aluminum and steel in these uses.

Heat exchangers are just one of many places Reynolds Aluminum is cutting costs in this industry. Its resistance to corrosion, its passivity, light weight and strength make aluminum *the* logical material for tanks, vessels, jacketing, piping, tubing, and other applications where corrosives must be handled or stored.

To learn how aluminum can cut your costs, write the people who know aluminum and its uses in the chemical and petroleum industry—*Reynolds Metals Company, P.O. Box 2346-CJ, Richmond 18, Virginia.* Or contact your local Reynolds branch office, listed under "Aluminum" in the classified phone book.

Write today for Reynolds free bulletins—
"Aluminum for Heat Exchangers" and "Keys to Corrosion".

REYNOLDS ALUMINUM

This doorway is the recent development by E. W. Bliss Co., Canton, Ohio, of process and machinery for converting copper powder into strip. Up to now, commercial exploitation of the Chemetals process for copper was limited by the relatively small market for copper powder.

Riding herd on this development is Fluor Corp. The Los Angeles engineering firm completed design work this summer on a 50-ton/day copper powder and strip plant proposed for a Midwest location. A major copper producer is now considering installing the $10-million plant.

The Chemetals process involves ammonia leaching of copper scrap (e.g., automobile radiators), followed by hydrogen reduction to the metal powder in autoclaves designed to operate at 375 F. and 1,200 psi. Powder will be roll-compacted into strip, continuously sintered at 50-100 F. below its melting point under a hydrogen atmosphere, then finished into specification-grade strip by rolling and annealing. Hydrogen will be made by the steam-iron route.

Fluor is leading from a position of technological strength. The firm for the past two years has been running a semicommercial plant using this process, a 7½-ton/day unit at Kansas City, Mo., owned by Whitaker Metals Corp. Fluor took over operation when the plant ran into difficulties.

A major windfall to process economics came recently when Fluor put into use at Kansas City an unidentified chemical additive discovered by Sherritt Gordon Mines, who operates a similar process to produce nickel (see Process Flowsheet, Jan. 1957, pp. 194-197). This additive boosted once-through yield of copper powder in the reduction step from 80% to virtually 100%.

Ammonia synthesis gas via LTC char

South Africa, site of the big Fischer-Tropsch oil-from-coal plant, will supply chemical engineers with a new conversation piece next year.

Subject: African Explosives & Chemical Industries' $28-million ammonia-urea project at Modderfontein. Items of particular chemical engineering interest:

- Low-temperature carbonization of low-grade coal in two Lurgi vertical units.
- Continuous oxygen-steam gasification of LTC char, instead of cyclic gasification of metallurgical coke in semi-water gas generators. (Several years ago Du Pont tried oxygen-steam gasification of coke at Belle, W. Va.; see *Chem. Eng.*, Oct. 1950, pp. 237-238.)
- Use of Kittel plates (see *Chem. Eng.*, Apr. 1953, pp. 242-243) instead of ring packing in the water scrubbing towers which remove CO_2 from the synthesis gas.

The AECI project is an expansion and modernization of an existing ammonia plant with a capacity of 75,000 tons/yr. Ammonia capacity will be boosted to 145,000 tons, and a 110,000-ton urea plant will be added. Project will include a 310-ton/day oxygen plant.

In line with today's thinking in U. S. and Europe (*Chementator*, Jan. 27, 1958, p. 53), AECI is negotiating with a petroleum refiner for sale of the 20 tons/day of oil produced when carbonizing 900 tons/day of coal.

AECI is not yet certain whether LTC char can be used with the one set of cyclic water gas generators which will continue to operate. As soon as char supplies are available, plant-scale trials will be conducted.

Are secrecy contracts monopolistic?

Monsanto's right to preserve its trade secrets by means of employment contracts—a right recently upheld in Salt Lake City District Court (*Chementator*, June 2, p. 43; Aug. 25, p. 51)—is being challenged in another court.

Central Farmers Fertilizer Co., defendant in a pending suit brought by Monsanto in District Court at Pocatello, Idaho, filed counterclaim on Sept. 16 in District Court at Boise.

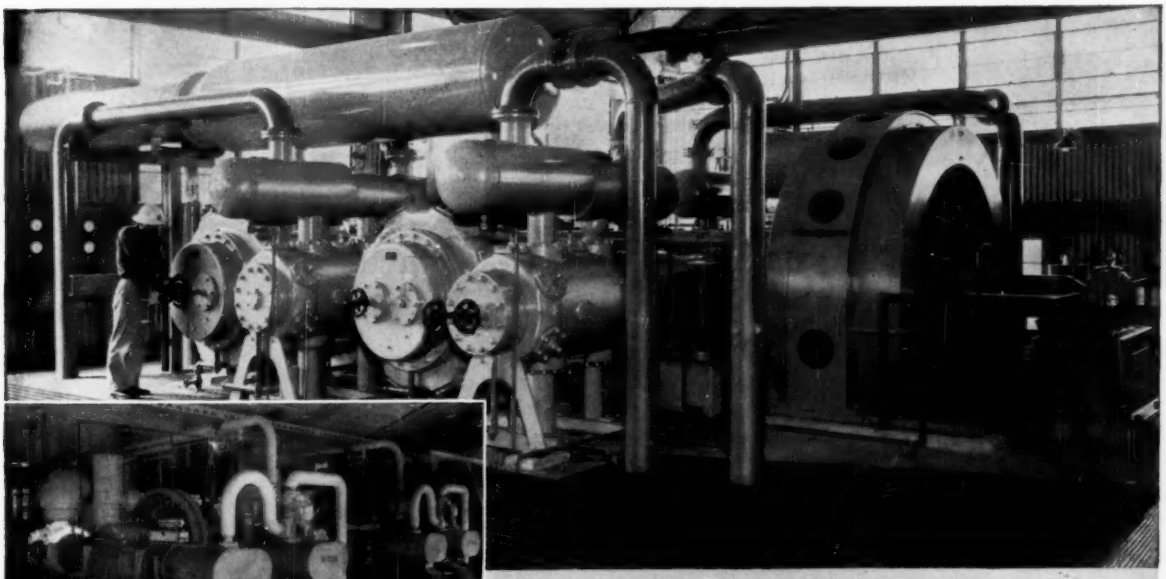
CFFC alleges that, in making employees sign contracts not to divulge trade secrets, Monsanto has a "scheme to create a monopoly in the manufacture of elemental phosphorus." The claim also alleges that Monsanto by its lawsuits has "frustrated, retarded, injured and damaged" CFFC in its building of a phosphorus plant at Georgetown, Idaho.

CFFC was not a defendant in the Salt Lake City trial. In that action, Monsanto obtained an injunction against former employee Charles M. Miller, restraining him from using Monsanto trade secrets in connection with CFFC's or any other phosphorus furnace.

In its charges of monopoly, CFFC is apparently taking its cue from the government's antitrust suit against Pfizer (*Chementator*, June 30, p. 47), which alleges that Pfizer's employment contracts protecting citric acid trade secrets are monopolistic.

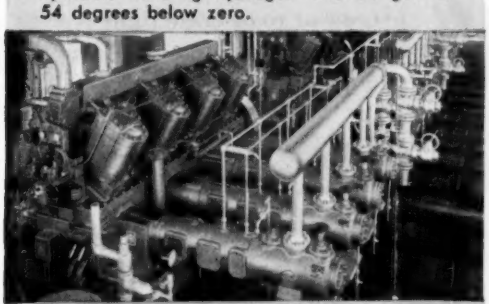
what assures a

GOOD COMPRESSOR for PROCESS WORK?

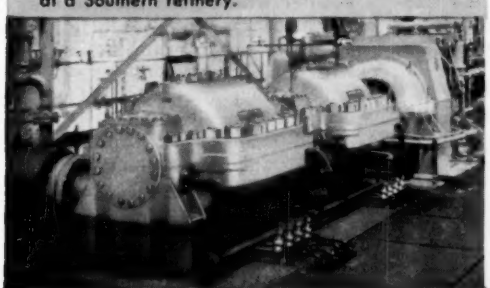


ELECTRIC-DRIVEN horizontal 4000-hp HHE compressor on multiple-gas service, compressing air to 645 psi, nitrogen to 330 psi and natural gas to 440 psi simultaneously in an ammonia plant.

STEAM-DRIVEN compressors with non-lubricated cylinders handling hydrogen chloride gas at 54 degrees below zero.



GAS-ENGINE compressors with non-lubricated compressor cylinders on hydrogen recycling duty at a Southern refinery.



CENTRIFUGAL compressors on ethylene refrigeration; these are tandem units driven by steam turbine.

In process jobs, any interruption of the cycle often means large loss of production, expensive repairs, and introduction of hazardous conditions. In manufacturing compressors for these jobs, there is one ingredient most vital.

That ingredient is knowledge. The compressor manufacturer must know how to predict conditions in the process which might force a shutdown, and must know how to meet those conditions with a compressor which will minimize the possibility of a shutdown.

Such knowledge is obtained only through years of actual experience in designing, building and applying compressors for all sorts of processes, for handling all kinds of gases, and for any range of pressures.

Ingersoll-Rand has more of that kind of experience than any other compressor builder. For information on process compressors for pressures up to 35,000 psi, contact your I-R representative or write direct. Ask for your copy of Form 3132A.

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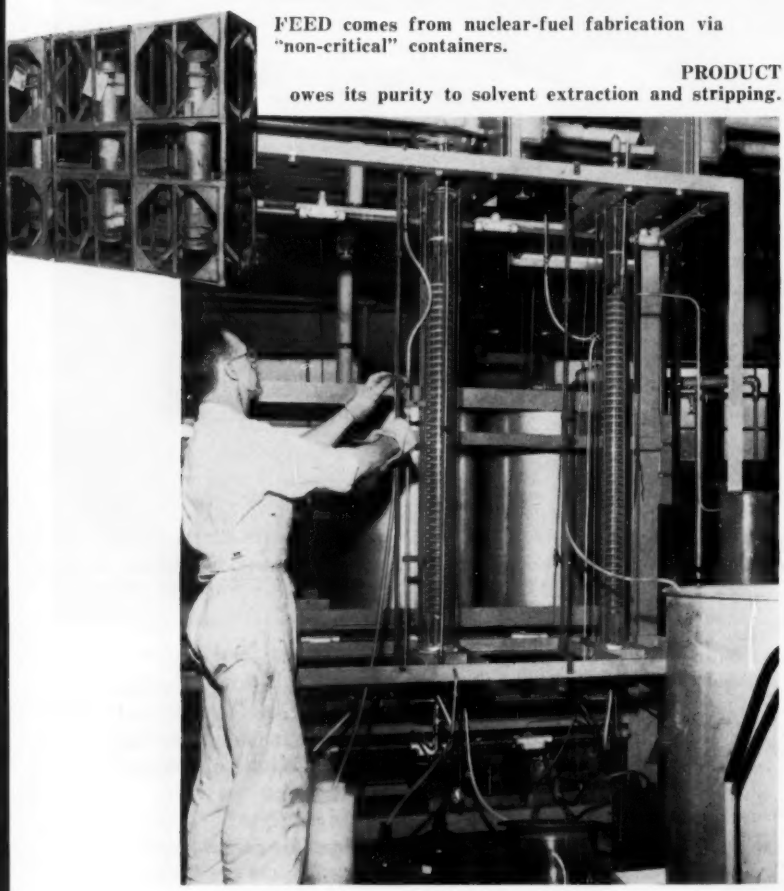


Valued at $2,500/lb., nuclear fuel scrap forces reprocessor to operate tight system to show high recovery and profit.

Reprocessor Wrings Profit From Cold Scrap

There's money in "cold" uranium scrap,* despite recent general feeling among private companies that reprocessing fails to return adequate profits. So reports Irvington-Baker Refining Div. of Engelhard Industries about its reprocessing plant at Newark, N. J.

First to enter the field of privately financed scrap reprocessing, Irvington-Baker's $200,000 capital investment in reprocessing facilities has returned adequate profits during 18-months' operation under license from the Atomic Energy Commission.

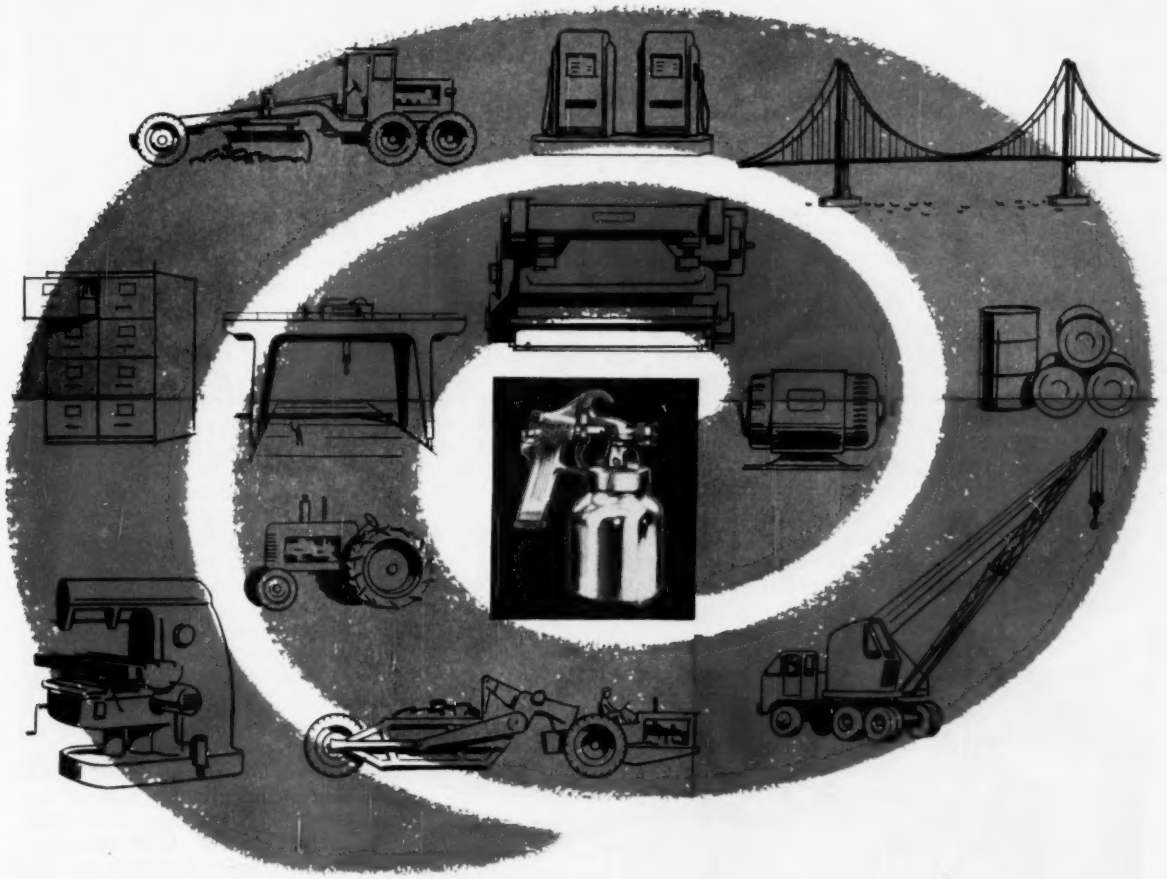
▶ To Profit: Take Any Scrap—Key to plant's economic success is process flexibility: Plant can handle almost any form of cold uranium scrap (most facilities are limited to a single type).

A typical week may find plant processing such diverse scrap as ingot ends, spoiled fuel plates, machine turnings, shavings, contaminated oxide powders and solutions. Baker converts all this scrap into U_3O_8 powder which goes back to the AEC for crediting to original customer's "uranium account" with the Commission.

Present plant capacity runs around 5 kg./day of 20% enriched uranium with provision for expansion as demand increases. Recovery of uranium averages over 98%.

▶ Customer List—Most of Baker's customers are fuel element fabricators in the U. S. who generate scrap worth about $2,500/lb. during extrusion, swaging and drawing of metals into final fuel elements. Plant also pro-

* "Cold scrap" hasn't been irradiated in nuclear reactor, doesn't contain highly radioactive decay products.



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cesses scrap from some Canadian firms and currently is negotiating for AEC scrap.

Baker reprocesses scrap as a contract service, doesn't actually buy and sell uranium because it belongs to the U. S. government.

▶ **Ingenuity Helps**—Practically every batch of scrap shipped to the Baker plant presents a unique problem. Complicating factors include form of scrap, impurities and alloying agents.

Choice of processing attack on a particular batch rests to a large extent on the ingenuity of production supervisor Eugene Nurmi. A chemical engineer with nine years' experience at Oak Ridge, Nurmi uses a combination of techniques developed originally by the AEC.

And every batch must be handled with care reminiscent of that college course in quantitative analysis. When you're handling a few kilograms of stock worth thousands of dollars, even small losses can be costly.

▶ **Varied Approach**—First step in recovery process is to get scrap into solution. Choice of reagent is influenced by presence in scrap of molybdenum, aluminum, zirconium or stainless steel alloying or cladding materials.

Depending on which of these different materials are in the scrap, Baker uses nitric acid, aqua regia or hydrofluoric acid as dissolving agent. Oxide powders call for use of nitric acid.

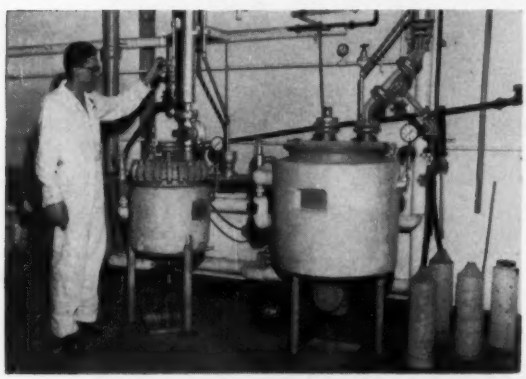
Dissolution takes place batchwise in stainless-steel or glass-lined kettles. To prevent radiation hazard from critical mass buildup, operators limit batches to 300-350 g. enriched uranium.

Next, chemical assaying gives uranium content of solution and this value is checked out with sender of the scrap for final agreement on amount of uranium to be returned.

Operators then adjust solution chemically for solvent extraction: Nitric acid brings acid content to 3N level and aluminum nitrate furnishes salt requirement during extraction.

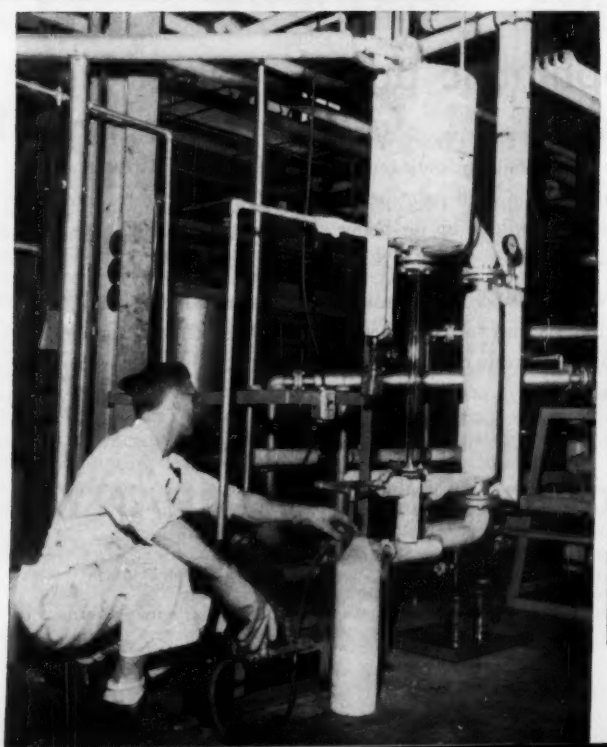
▶ **Uranium, Kerosene & TBP**—After adjusting solution, operator runs it through a York-Scheibel column where a 30% mixture of tributyl phosphate (TBP) in kerosene extracts uranium values. In a second column, dilute HNO_3 strips uranium from TBP. Both columns stand 5 ft. high, have 3-in. dia. and 42 contacting stages.

Dilute aqueous solution from stripping column goes to a thermal siphon evaporator (fabricated by Baker for this

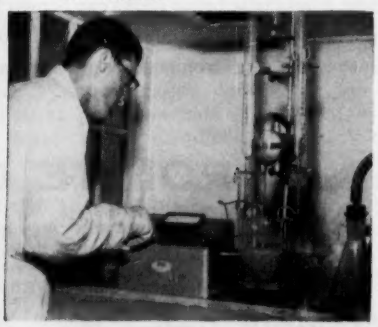


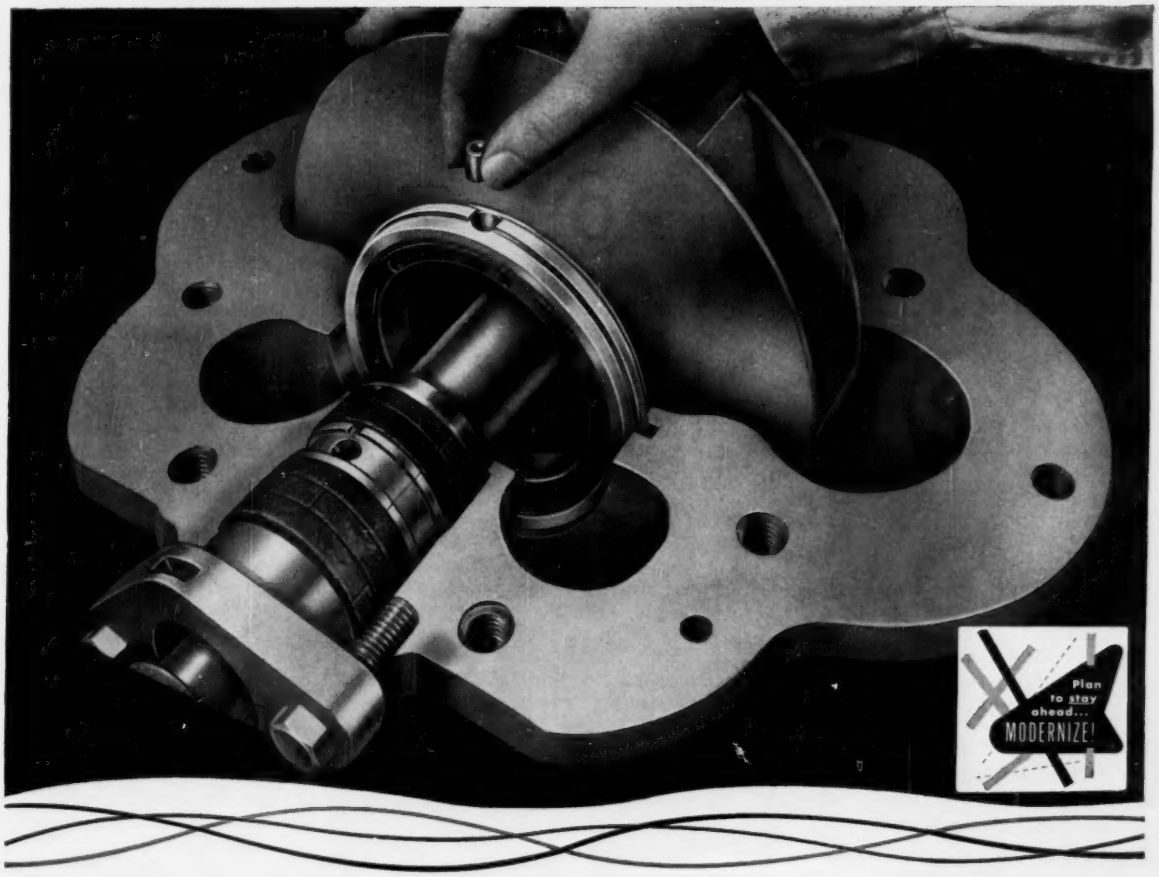
DISSOLUTION in glass-lined or stainless kettles readies scrap for extraction.

CONCENTRATION by thermal siphon evaporator precedes precipitation of UO_4.



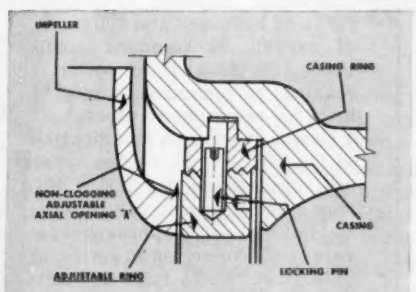
PRECIPITATION of UO_4 by H_2O_2 takes place at pH 2 to keep impurities in solution.





Eliminate pump jamming

...prolong high efficiency with adjustable wearing rings



Adjusting for Wear

All you remove is the top half casing and locking pin, then turn adjustable ring to desired clearance "A". Replace locking pin in newly drilled hole. Replace casing and pump is ready.

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specific application) for concentration from 0.25 to 1.0 N.

Operator then precipitates uranium peroxide (UO_4) from concentrate by controlled addition of hydrogen peroxide at pH 2. Precipitating at pH 2 ensures that impurities such as Fe and Al are left in solution, whereas with NH_4OH precipitation used formerly they would come down.

In final step, the UO_4 precipitate undergoes firing at 1,650 F. for conversion to black U_3O_8 powder. Again solid mass is limited to 350 g. to prevent radiation hazards. Fired product is ground in small ball mill to −200 mesh before shipment back to AEC.

▶ **Not Much Hazard**—Dangers involved in processing unirradiated uranium scrap are no greater than in handling any other poisonous material. Observes one Baker official, "You just have to be sure that no one spreads it on their sandwiches."

Certain precautions, however, are designed into process to thwart any radiation buildup in enriched scrap which contains around 20% U_{235}.

As noted, operators limit batch operations to 300-350 g. And vessels containing enriched uranium solutions are limited to 5-in. maximum diameter with a minimum of 2 ft. between centers. Concentrated solutions, for example, are stored in 5-in. plastic bottles, each equipped with its own special cart to keep it at least 2 ft. away from any other bottle.

Every operator wears a film badge that is checked periodically to make sure that he hasn't been exposed to excessive radiation over extended intervals.

As another precaution, all exhaust fumes from plant pass through absolute filters that catch all particles down to 0.3 microns, preventing possible discharge of radioactive material to the atmosphere.

Waste disposal isn't much of a problem. All solutions are collected in drums and checked for contamination prior to dumping. No special sewage system is needed.

▶ **Hot Scrap Next?** Baker officials admit they are interested in possibility of expanding into hot scrap reprocessing field (see p. 62).

But they are quick to point out that the technical and economic problems are multiplied manyfold when handling irradiated uranium. Process remains essentially the same, but shielding, remote-control handling, operation, maintenance and waste disposal problems all complicate the economics.

It's admittedly a far touchier situation than the relatively clear-cut cold-scrap picture. And so far, all private firms are maintaining a wait-and-see attitude, leaving hot reprocessing to the AEC.

Slurrying Setup Readies Coal for Pipeline

Pittsburgh Consolidation Coal Co.'s facilities at Georgetown, Ohio, prepare coal slurry for its 108-mi. pipeline journey to Cleveland Electric Illuminating Co.'s Eastlake, Ohio, plant. Now in full operation, pipeline has capacity of 150 tons/hr. of slurry which contains 50%, by weight, of coal.

Pressurized Electrolyzer Produces Hydrogen

Commercial production of hydrogen by high-pressure electrolysis of water is now feasible with cells built by Lurgi Gesellschaft, Frankfurt, Germany.

Designed for 425 psig. operation, the units require lower specific power consumption than conventional atmospheric pressure units, and compression of the final product is reduced or eliminated completely. For 1,000 cu. ft. of hydrogen and 500 cu. ft. of oxygen, at standard conditions, 123-129 kwh. of power is required as compared to 140-160 kwh. for atmospheric process.

▶ **How It Works**—A modification of the bipolar (filter-press type) cell construction popular in Europe, the Lurgi electrolyzer consists of 400-600 diaphragm-separated cells connected in series. A potential of up to 1,200 d.c. volts is applied across the unit.

Caustic potash electrolyte (sp. gr. 1.25) circulates through anodic and cathodic chambers of each cell. Gases travel with electrolyte to separators after which the solution recycles. Distilled water makeup washes collected gases, then joins electrolyte.

Available units produce 7,000-21,000 cu. ft. of hydrogen per hour, but the company sees no technical hindrance to larger installations.

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Here's an amazing advance in motor technology! It's the *Super-Seal* motor line — an open motor design so completely unaffected by moisture, dust, dirt, oil, acids and alkalis that it can be used in many applications previously requiring more costly enclosed motors. *Savings range from 15 to 60%.*

Super-Seal motor superiority results from revolutionary insulating techniques. Available in any integral horsepower size, smaller *Super-Seal* motors incorporate an encapsulated stator. A durable epoxy resin encloses the stator, creating an electrical system impervious to outside elements.

In larger sizes, *Silco-Flex* insulation is used. In this system, silicone rubber is vulcanized into a homogeneous mass to form a flexible, moisture and heat resistant, void-free dielectric barrier around coils and leads.

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BARIUM OXIDE product mixed with unreacted carbon flows from primary reactor.

Lower Process Temperature Ups BaO Quality

By rigid control of operating tricks, new barium-oxide process avoids temperature level where purity-robbing eutectic forms.

In the face of rising interest in high temperature processing techniques, Barium Reduction Co., South Charleston, W. Va., reports a notable advance toward lower temperatures.

Using a new fluid-bed process, Barium Reduction Co. reduces $BaCO_3$ to BaO at a temperature level of 1,680 F., some 500-800 deg. below conventional reduction level in arc furnaces.

Product reaches 97-99% purity, 8% higher than average purity of the arc-furnace product. Even with a premium price tag, this high-purity material is claimed more economical than barium hydrates as an additive in lubricating oils.

Process was developed on a small pilot scale and patented by Columbia-Southern Chemical Corp. Commercialization by the Barium Reduction Co. required two more years of development under Barium Reduction's Technical Director, Mr. L. Preisman, recognized barium authority.

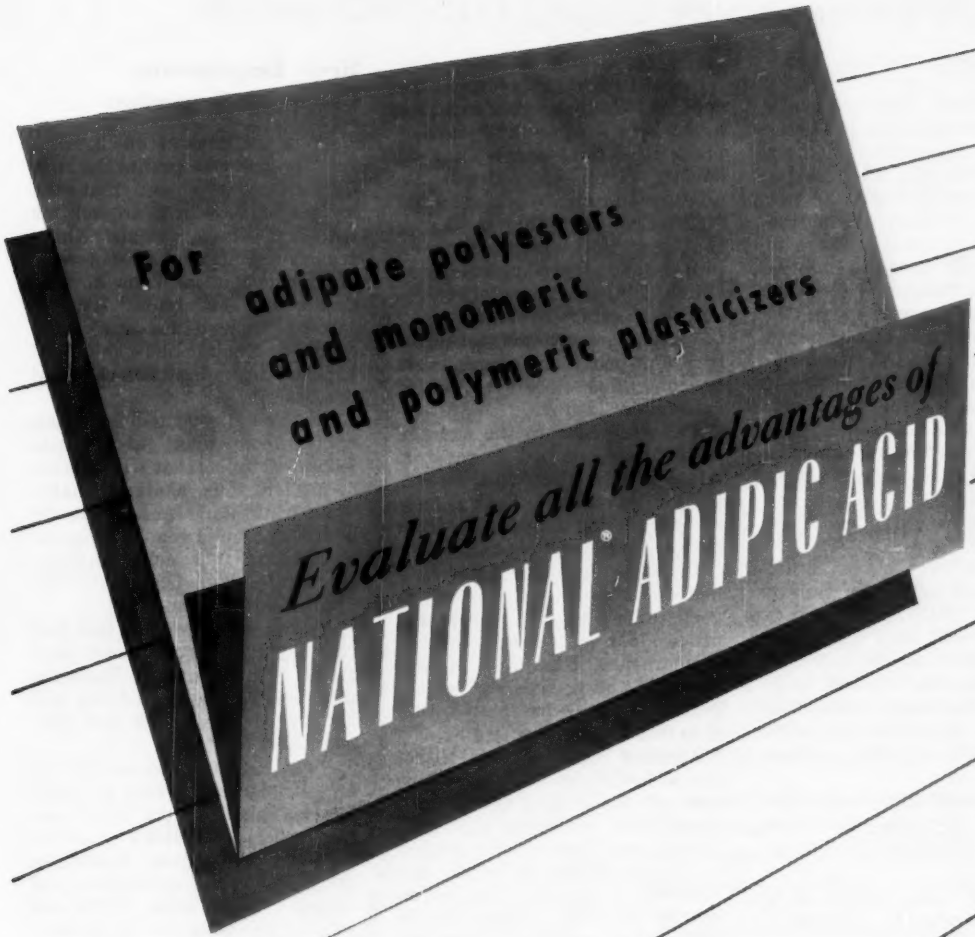
▶ **Eutectic Hampers Reduction** —At the temperature required to reduce $BaCO_3$ by electric arc, according to reactions:

$$BaCO_3 \rightarrow BaO + CO_2$$
$$CO_2 + C \rightarrow 2CO$$

a $BaCO_3$-BaO eutectic mixture forms localized fused spots which prevent complete reduction of the charge. At best, product purity is about 90%. And even this purity level rests on careful sorting to eliminate fused pieces.

▶ **Prevent Fusion** — Through careful control of operating conditions, Barium's fluid-bed reactor avoids this pitfall. By maintaining bed assay above 90-92% BaO and holding temperature close to 1,680 F., Barium Reduction avoids formation of a eutectic mixture. Thus, each particle is free to undergo virtually complete reduction.

To achieve a reaction at this low temperature, Barium Reduction lowers the partial pressure of CO by using nitrogen sweep gas to fluidize the bed and re-



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move gaseous reaction products.

▶ **Hold Uniform Temperature**—Barium Reduction Co. produces 20 tons/day of product with six reactors. Standing 20 ft. high, these reactors operate as two stages: a primary reduction stage and a secondary stage to burn off excess carbon reducing agent. Each reactor is enclosed by a gas-fired furnace having 35 burners positioned to distribute heat uniformly to the reactor.

Thermocouples at 13 different locations on reactor shell control firing rate and shell temperature. Two thermocouples in bed control feed rate. Acting together these controls hold bed temperature within 5 deg. of set point.

▶ **Start With Ore**—Manufacture of BaO starts with reduction of barite ore ($BaSO_4$) in rotary kiln, using coal with high fixed carbon content as the reducing agent. The BaS black ash, leached with water, yields solution which is carbonated with either Na_2CO_3 or CO_2 to form $BaCO_3$.

Under carefully controlled conditions, Barium Reduction dewaters and washes the barium carbonate in a continuous centrifugal to a specified moisture content. Wet cake goes to a pug mill where it mixes with carbon black to a final consistency of 65-68% solids. On a dry basis, mixture contains 6.3% carbon.

▶ **Pelletize to Fluidize**—From the pug mill, mixture feeds into rotary dryer-agglomerator which delivers dry pellets to reactors. Moisture content in feed to agglomerator, gas temperature and bed temperature must be controlled closely to obtain satisfactory pellets.

Pellets feed onto the surface of the fluidized bed in reactor. After several hours in the reactor, fully reduced BaO pellets discharge intermittently from bottom by manual control.

Because discharge from fluid bed contains excess carbon, it goes to "whitener" reactor for processing at slightly higher temperature. Final shot of oxygen burns off the remaining carbon. Operating batchwise, this step in process takes ½-¾ hr.

▶ **Keeping Solids Fluid**—Nitrogen at 2,000 cfm. enters the bottom of the reduction reactor. Distributor delivers gas uniformly over tower cross section to fluidize charge uniformly and minimize slugging. Gas leaves reactor through cyclone which removes entrained dust and returns it to reactor.

Nitrogen comes from combustion generator via monoethanolamine and caustic-soda CO_2 scrubbers, followed by cooler and silica gel dryer which remove water.

At point of entry to reactor, nitrogen is completely free of CO_2 and O_2, with only a trace of CO. Moisture content of the nitrogen must be less than 0.0009 lb./1,000 cu. ft. at −80 F. to avoid formation of barium hydrates.

An oxygen analyzer continuously checks the nitrogen stream to detect any variation from the specified 0.00% O_2 content. A continuous bleed bubbles through $Ba(OH)_2$ solution to signal any presence of CO_2.

While Barium Reduction now reaps the fruits of this modern process, Preisman and his associates attest that only through their combined talents could they reduce it to practice.

SCRUBBERS guard purity of N_2 sweep gas flowing to reactors.

Reds Emphasizing Chemical Expansion

From the amount of chemical activity going on behind the Iron Curtain, it's evident that the Reds aren't waiting around for the West to act on Nikita Khruschev's bid for increased flow of Western chemical know-how to Communist countries. Reports seeping under the Iron (and Bamboo) Curtain show the Reds' widespread emphasis on chemical processing:

Soviets are reportedly erecting an oil-shale plant at Kochtla Jarwe, Estonia, that will process 4 million tons shale annually.

And Russians are supplying equipment for a coal hydrogenation plant that is under construction at Fushun, China, 100 mi. from North Korea.

Peking Radio reports that Red China plans to start seven synthetic fiber plants in Shanghai this year; among products will be Terylene, nylon 66 and pilot quantities of Orlon.

Red China has also ordered six oxygen plants and four nitrogen fixation plants from Czechoslovakia and is planning a plant for recovery of sodium, potassium and magnesium chlorides and magnesium bromide from sea water. Construction is already under way at Tientsin on catalytic sulfuric acid works with annual capacity of 40,000 tons.

Fluorine Harnessed for Rocket Propellant Use

Crowning intensive research into handling properties of liquid fluorine, Bell Aircraft Corp., Buffalo, N. Y., has now successfully used it as a chemical oxidizer in large-scale rocket thrust-chamber firings.

Significance of this, Bell points out, is that specific impulse of rocket propellants can be hiked, through use of liquid fluorine, to 300-345 lb./sec., compared to 245 lb./sec. thrust of liquid oxygen-kerosene propellants. Rockets can carry bigger payload.

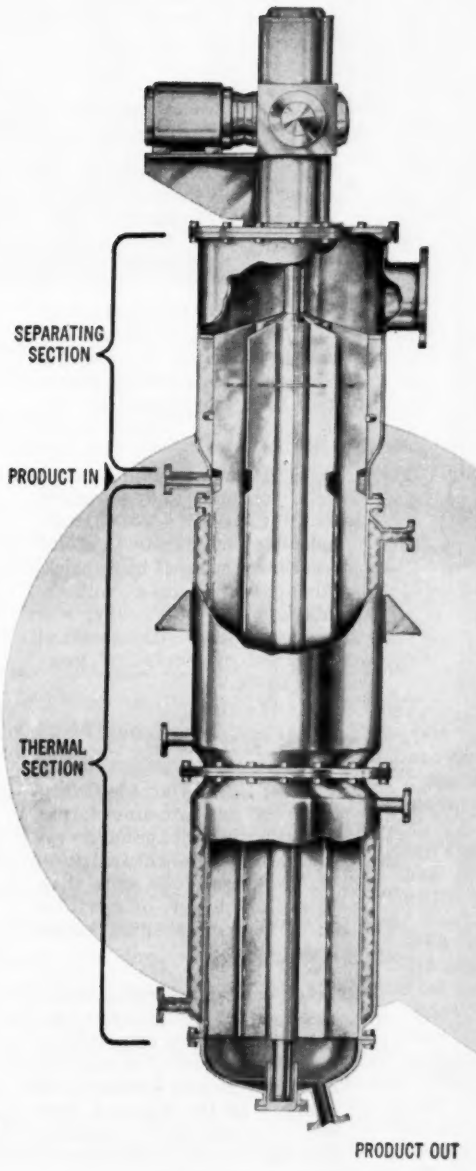
Bell developed special techniques in handling, metal treatment and welding for all rocket thrust-chamber components. Special test facility holds liquid fluorine at −306 F.

Solve Difficult Liquid Processing Problems

with the New

RODNEY HUNT

TURBA-FILM®
MARK II
PROCESSOR



When viscous fluid processing is "bugged" by complex procedures, time-at-temperature-sensitive materials, sluggish control of product quality . . . look to the new Rodney Hunt Turba-Film Mark II Processor to simplify your problems.

Utilizing a turbulent thin-film technique, the patented Turba-Film Mark II Processor provides mechanically aided heat and mass transfer *in one pass, continuously and rapidly,* for a wide range of viscous fluids and slurries. It delivers controlled uniformity of product in

concentration . . . deodorization . . . dehydration . . . evaporation . . . heat transfer . . . reaction . . . stripping . . . and other processes.

Short-time exposure and minimum hold-up of the process fluid in the thermal section assures uniform heat and mass transfer, even at high temperature. Foaming is controlled by a mechanical separator and the formation of crust is minimized permitting continuous operation for long periods.

A large number of installations have proved conclusively the superiority of the Turba-Film Processor for processing chemicals, pharmaceuticals, lactices, solvents, foods and many other products.

An Invitation

Rodney Hunt will be happy to work with you in solving your process problems, utilizing its extensive engineering, laboratory and pilot plant facilities. Address your inquiry to the Rodney Hunt Process Equipment Division or write for Catalog 117, the story of the Turba-Film Processor.

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SERVING THE PROCESS INDUSTRIES WITH EQUIPMENT AND ENGINEERING

UNIT shows absorbers and strippers for CCl_4 (left) and Cl_2 (right).

New Scheme Cuts HCl Purifying Cost

Hooker Chemical Corp. has come up with a process which it claims gives an economical answer to that old problem of purifying byproduct HCl from organic chlorinations.

Just-patented process (U. S. 2,841,243) is installed at Hooker's Montague, Mich., plant to clean up anhydrous HCl which is piped on a large scale to Du Pont's nearby neoprene facility.

Hooker claims that capital investment for its two-solvent process is about one-half as much as for the older hydrochloric acid absorption-desorption procedure.

▶ **Old Versus New**—Hydrochloric acid process is in most common use today. Gas stream containing HCl and impurities is scrubbed with aqueous hydrochloric acid, dissolving HCl. Anhydrous HCl is distilled out of the solution and azeotropic HCl mixture is recycled. This system has two drawbacks: Corrosion is a serious problem and chlorine recovery is tricky.

Hooker's route takes the opposite approach. Instead of absorbing HCl and leaving impurities behind, impurities are stripped out leaving product HCl with less than 10 ppm. Cl_2. In this way, utility costs are lowered and corrosion headaches are eliminated —mild steel is used throughout Hooker's setup.

▶ **Two-Zone Stripping** — First step is to absorb chlorine and most of the organic impurities from the chlorination off-gas.

Gas, containing about 88% HCl (by weight), 9% Cl_2 and 3% organics impurities, flows to a packed tower and is scrubbed with carbon tetrachloride. Overhead fraction leaving absorber contains around 50% CCl_4, 49.5% HCl and only 0.02% Cl_2. This stream then flows to carbon tet absorber at 95 F. and is scrubbed with hexachloro-butadiene; effluent HCl from top of tower is further purified by compressing and recycling through a third scrubbing column where it contacts more hexachloro-butadiene at 5 F. Final anhydrous HCl product contains virtually no chlorine or carbon tet and only 0.01% hexachloro-butadiene.

Chlorine and dissolved HCl in bottoms from first absorber can be boiled out and recycled to chlorination unit. Carbon tet dissolved in hexachloro-butadiene is recovered by distillation and recycled to first scrubbing zone.

Hooker is currently studying plans to license the process.

More Seawater Magnesia Slated for Production

Now nearing completion at Pascagoula, Miss., multimillion-dollar seawater magnesia plant of H. K. Porter Co.'s Refractories Div. will be on stream late this year.

And away to the east—Port St. Joe, Fla.—will be the site of Michigan Chemical Corp.'s 125-150-ton/day seawater magnesia plant. Michigan Chemical has now completed construction plans.

H. K. Porter will produce a line of chrome and periclase specialties in addition to chrome-magnesite, magnesite - chrome and periclase types of basic brick.

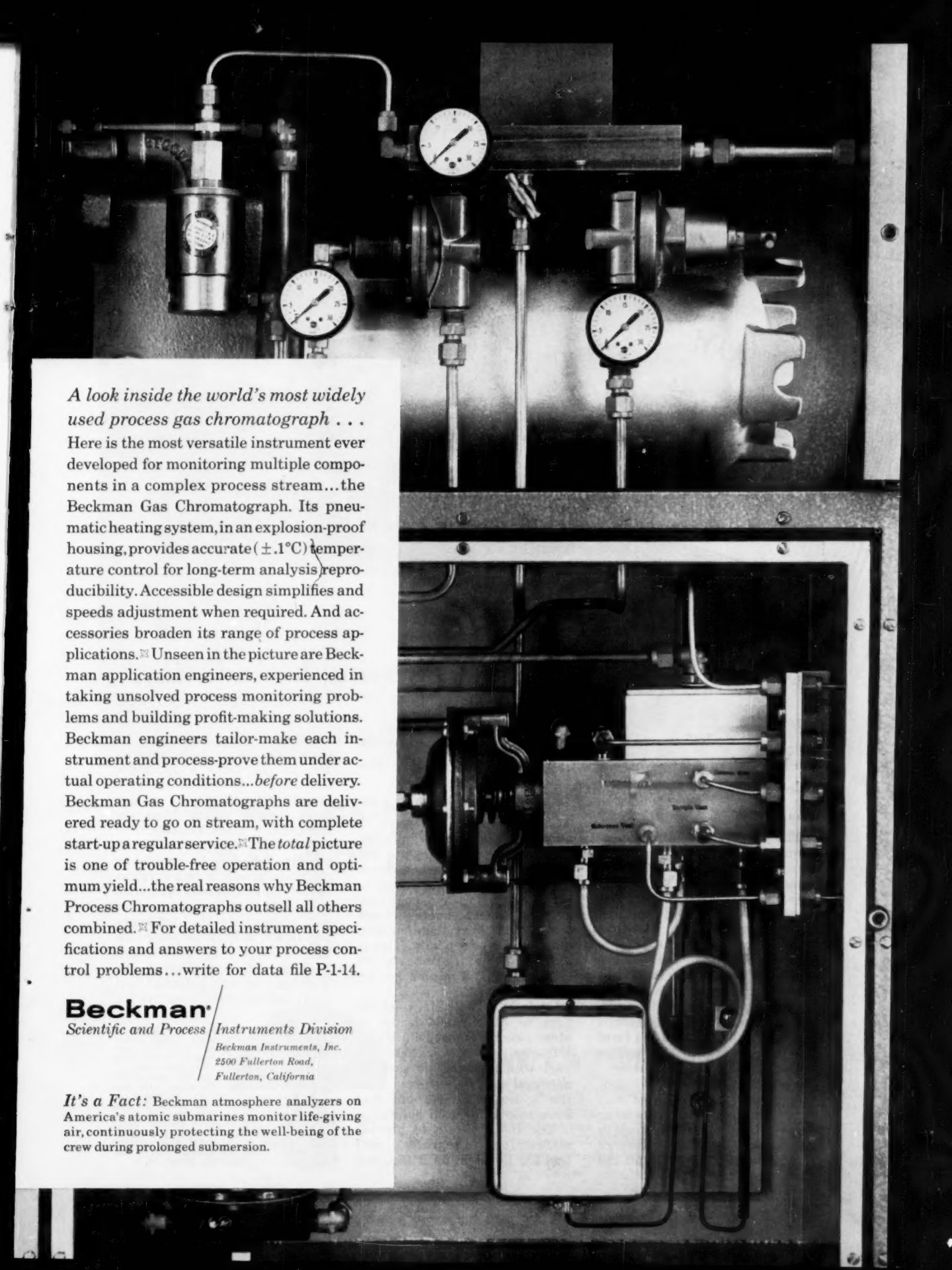
Michigan Chemical's plant, expandable to 300 tons/day, will turn out high-purity chemical and refractory grades of magnesium oxide.

NEWS BRIEFS

Expoxies: Union Carbide Chemicals Co. has announced that it will build an expanded version of a new unit at Institute, W. Va., to produce more than 10 million lb./yr. of epoxides and other oxygenated chemicals.

Reactor coolant: Siemens-Schuckertwerke, A. G., has developed nitrogen tetroxide as gaseous coolant for nuclear reactors. In two temperature ranges—50-150 C. and 300-600 C.—nitrogen tetroxide dissociates into products with high specific heats.

Acetylene process: Tennessee Eastman is making available for license its flame cracking process for simultaneous production of ethylene and acetylene (*Chem. Eng.*, Jan. 27 1958, p. 58). Under license contract, Stone & Webster Engineering Corp., Boston, Mass., will design and build plants in the U.S. and will represent Eastman in foreign licensing.



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Here is the most versatile instrument ever developed for monitoring multiple components in a complex process stream...the Beckman Gas Chromatograph. Its pneumatic heating system, in an explosion-proof housing, provides accurate (±.1°C) temperature control for long-term analysis reproducibility. Accessible design simplifies and speeds adjustment when required. And accessories broaden its range of process applications. Unseen in the picture are Beckman application engineers, experienced in taking unsolved process monitoring problems and building profit-making solutions. Beckman engineers tailor-make each instrument and process-prove them under actual operating conditions...*before* delivery. Beckman Gas Chromatographs are delivered ready to go on stream, with complete start-up a regular service. The *total* picture is one of trouble-free operation and optimum yield...the real reasons why Beckman Process Chromatographs outsell all others combined. For detailed instrument specifications and answers to your process control problems...write for data file P-1-14.

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It's a Fact: Beckman atmosphere analyzers on America's atomic submarines monitor life-giving air, continuously protecting the well-being of the crew during prolonged submersion.

. . . Cue for Atom-Fuel Processing by Industry?

Chemical processors, long wary of going it alone in nuclear fuel processing, have new reasons for giving the role another, more confident look.

John A. King, Assistant Editor

The case for chemical processing in nuclear-fuel recovery got a mighty boost recently when the outgoing 85th Congress ratified the U. S.-Euratom plan for developing atomic power abroad.

True, the paths to fuel-service markets are still not strewn with rose petals. But the Euratom (European Atomic Energy Community) agreement promises that new, firm markets will be a reality by 1963, in the form of 1 million kw. of nuclear power capacity in Europe.

Serving to further whet chemical-industry interest: the lode of nuclear-fuel processing know-how disclosed last month at the U. N. Atomic Energy Conference in Geneva; and the news now that private industry is already nibbling at the nuclear-fuel processing business (see pp. 50-54 this issue).

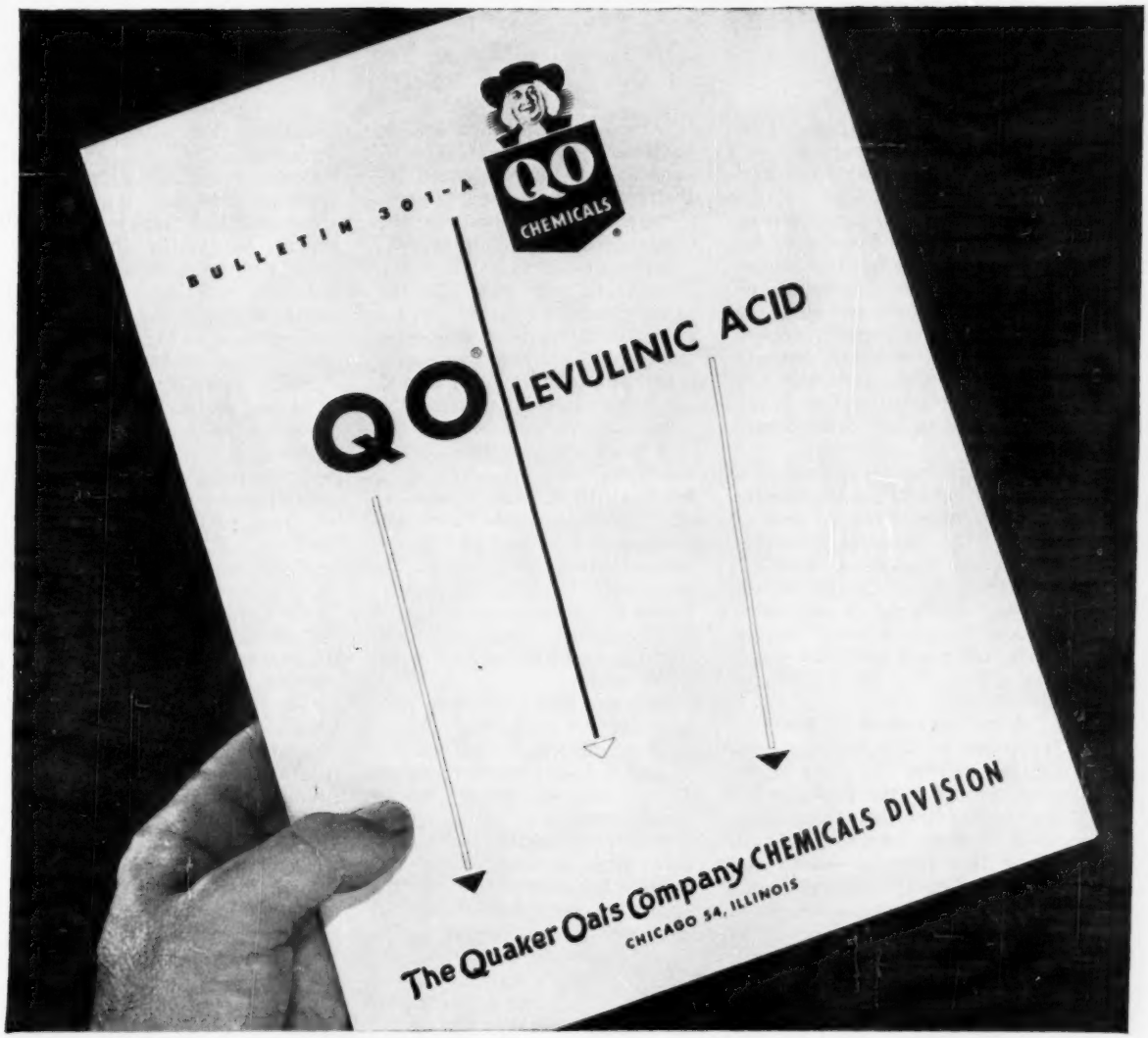
Euratom's capacity goal may prove a bigger, nearer target for U. S. industry than our own planned power capacity. This is scheduled to reach only 700,000 kw. by 1961, 1.3 million kw. by about 1965.

▶ **Uncle Sam Will Help**—Uncle Sam, as Free World leader in atomic energy, must help if this Euratom goal is to be met. The pact which won Congressional approval says he will help. And that's something no one has been able to bank on before.

The U. S. agrees to provide nuclear fuel; to reprocess spent fuel for Euratom until facilities are available in Europe or on a commercial basis in this country; to guarantee a maximum fuel-cycle cost to Euratom buyers of 4.2 mills/kwh., unless equivalent or better offers are forthcoming from industry.*

▶ **Fuel-Cost Pledge**—If U. S. private industry is unable to maintain products and services below the guaranteed maximum fuel-cycle cost, the government will underwrite the difference (up to $90 million between now and 1973). This government backing puts a ceiling on the European buyer's potential fuel costs and provides incentive for

* U. S. government and industry agree to do many other things under the U.S.-Euratom pact. They will fabricate and sell fuel elements containing 30,000 kg. of U-235; and purchase all plutonium produced in the course of reactor operation. Euratom and the U.S. will each invest $50 million over the next five years on research and development to reduce present fuel-cycle costs and improve reactor technology. And the U.S. will lend up to $135 million of the total $350 million estimated to be the capital cost of the 1-million-kw. Euratom program.



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private-industry entrance into the business.

For uranium processors and fuel-element fabricators, Euratom power means expansion of business already devoted to domestic operations. For those companies which already, or might, sell services—such as fuel-fabrication-scrap recovery and radioactive-waste disposal—to the nuclear industry, the government help implied in the U. S.-Euratom pact is an attraction.

▶ **Reprocessing Chancy**—But a great uncertainty still obscures the ripest, most logical field of all for the chemical industry: spent-fuel processing. Now exclusively the responsibility of Atomic Energy Commission plants, this operation is fraught with both profit peril and potential (*Chem. Eng.*, July 1957, pp. 202-206).

With the volume of business proposed by the Euratom program, private industry could conceivably enter fuel reprocessing for the first time. However, fuel-reprocessing's share (and this includes waste disposal) of total fuel-cycle costs of 4.2 mills/kwh. is estimated to be a slim 0.3 mills. Such an allowance surely calls for the most economical method that's technically feasible.

Which fuel-reprocessing method is technically and economically the best? Or is there any technology now which will permit any other than the AEC-husbanded setup we have today?

▶ **Try "Cold" Scrap First**—Perhaps the most likely candidate to pioneer private spent-nuclear-fuel reprocessing is some company which first recovers "cold", or non-radioactive, fuel-fabrication scrap. Such a company is the Irvington-Baker Refining Div. of Englehard Industries, which operates the first privately owned plant in the scrap-reprocessing field (p. 50).

Scrap recovery is much like spent-fuel reprocessing; the same solvent extraction process is employed. Only the shielding, waste disposal and remote operation and maintenance necessary with hot, or irradiated, fuel is missing (as well as a mighty stiff additional capital investment).

▶ **Versatility Comes First**—Today nuclear fuels are reprocessed domestically by the solvent extraction process. Its principal virtue is versatility. Solvent extraction can handle all types of irradiated fuel, metallic and non-metallic (uranium oxide).

It is the only technique suitable for the oxide fuels which are the choice in Europe because of their low enrichment (3% U-235) and modest inventory charge.

Solvent extraction, though, is rife with economic disadvantages. Inherently a complex operation with many steps, it requires a high capital outlay—as much as $11,000/kg. of daily uranium capacity—even for a small capacity. Large throughput has been the answer in AEC facilities and is the reason why private industry, if it is to compete, must do so in large, centrally located plants.

And the reason why Eurochemic, the company formed by 12 European countries, will finish building in 1961 a pilot plant at Mol, Belgium—the model for future, and much larger, facilities—to handle spent fuel from all six Euratom countries.

▶ **Costly Shipping**—Solvent extraction requires shipment of irradiated fuel from reactors to central processing sites. Shipping hot fuels involves lead-shielded containers. Container costs can run, for highly enriched fuels, as high as $25,000/kg. of uranium contained.

One possible solution is interim "cooling" before shipment so that shielding can be lighter. An economic balance must be reached between cost of shipping hot fuel and cost of carrying cooling fuel in inventory.

For inventory is a vital factor in the overall economic picture. With highly enriched fuel worth $15,000/kg., the less material tied up in nuclear fuel-cycle inventory the better.

Unfortunately the fuel cycle in solvent-extraction processing carries the equivalent of several reactor charges: one charge undergoing fission in the reactor, another in transit between reactor and reprocessing plant, another being reprocessed.

▶ **Nasty Wastes**—Another fly in the ointment for solvent extraction is waste disposal. As much as 800 gal. of high-level wastes/kg. of uranium reprocessed gush from the process plant.

Now we can only cool, or deactivate, them for a period, concentrate them by evaporation, and store them in massive underground tanks, shielded by concrete and equipped with miles of stainless-steel coils to remove heat of radioactive decay (photo, this page). Here hot wastes decay before sea burial in concrete containers.

We do this because we know of no other sure way to handle these materials.

First steps alone run from $2 to $10/gal.; ocean burial, about $1/gal. concentrate. These costs are far in excess of recommended costs for Euratom, which allow only about one-tenth of total reprocessing costs, or 0.03 mills/kwh.

Fluor Corp. is working on a method whereby liquid wastes are calcined and converted to compact, easily stored waste. At Hutchinson, Kan., the AEC,

DISPOSAL COSTS abound at Idaho Falls tank farm for radioactive waste.

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assisted by the American Petroleum Institute, is seeking ultimate storage of low-level wastes in the depths of salt domes. And Nuclear Engineering of Walnut Creek, Calif., is developing lower-cost ocean burial of the same wastes.

In spite of high costs of waste disposal—inventory, transportation, capital outlay—solvent extraction will live on as an important method of reprocessing. The trend in Europe toward non-metallic, uranium oxide fuels will help see to that.

▶ **Special Methods**—There are other methods of fuel reprocessing which have few of solvent extraction's economic ailments. Although not yet in production, they will compete on suitable, metallic fuel.

In the pyrometallurgical method, decanned fuel elements are melt-refined. Fission products are absorbed in furnace walls, in an oxide slag, or are volatilized.

Advantages are short interim cooling periods, easy-to-handle wastes, compact on-reactor-site processing. Inventory costs are cut, shipping costs eliminated.

Atomics International and Argonne National Lab are trying to integrate a pyrometallurgical process in a single reactor's fuel cycle. Argonne's fuel-processing work with Experimental Boiling Water Reactors may pay off in Europe where the first reactors are of the same types—probably pressurized and boiling water types—as those already checked out in the U. S.

▶ **For Metallic Fuel Only**—Pyrometallurgical processing, it should be repeated, can handle only metallic fuels; blanket fuel elements will have to be processed at central solvent extraction plants.

Fluoride volatilization is another proposed integrated processing scheme for metallic fuel. It boasts the same virtues as pyrometallurgy, but involves more steps. Fuel elements are decanned, and fluorinated. Volatile uranium hexafluoride is distilled and reduced to metal for refabrication into fuel elements.

For work Argonne is doing on these and other projects—extraction with molten metal or salts, fractional crystallization of uranium-zinc complexes, electrodeposition—see *Chem. Eng.*, Sept. 22, 1958, p. 69. These new techniques have yet to be proven feasible, let alone economical.

Computer to Probe Methanol-Formalin Future

Chemical market forecasting will never be an exact science. But electronic data-processing machines now promise an extended coverage never before approachable.

Taking the cue, Celanese plans to turn its medium-sized computer at Corpus Christi, Tex., loose on the market future—first on close-range sales forecasts, then on longer-view evaluations of chemical potential.

High on the list for Celanese researchers will be methanol and formaldehyde—two interrelated chemicals whose national capacities have continued to grow substantially during the past several years despite a leveling off in demand.

Today's capacities for both products are sufficient, if totally utilized, to satisfy projected U.S. requirements for the next 5-8 yr. or longer.

▶ **Captive Capacity**—One of the problems in these two basic chemicals has been the large portion of new capacity that is captive. This, in effect, has worsened marketing problems of established merchant producers. For it's one thing to have new competitors for your customers, and quite another thing to find your former customers supplying their own needs.

This overcapacity of merchant producers of formaldehyde and methanol has produced a highly competitive marketing situation the past year. Recent price reductions in both chemicals were a direct reflection of this imbalance.

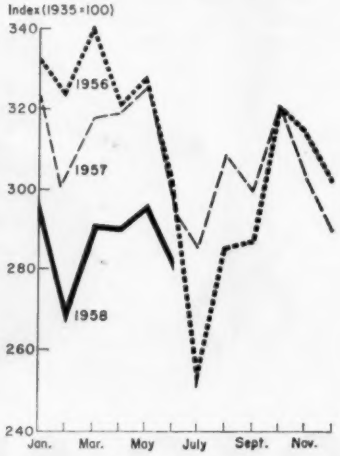
▶ **Looking Ahead**—In a year which has been a rough one for many producers, Celanese claims it has managed to keep formaldehyde and methanol inventories within desired limits, has, in fact, been operating at capacity.

For this the company thanks its internal efforts to build methanol and formaldehyde into highly marketable derivatives like paraformaldehyde, trimethylolpropane, trioxane and acrylic esters. Even so, Celanese is looking to the future and wants even better tools with which to do it.

Celanese knows full well that no one factor—be it raw materials cost, freight charges, product price, technology changes, plant size, or even end-product breakdown and volume—wags the whole market setup. So dovetailing all these factors together in a computer will give new insight as to how they combine to describe the profitability pattern of any chemical.

Biggest benefit, perhaps, will accrue from being able to better anticipate effect, on chemical demand, of trends in the ultimate chemical-consuming industries, however remote.

Chemical Consumption



Consumption by Industries

	May (Final)	June (Est.)
Coal products	7.3	7.4
Explosives	9.5	9.8
Fertilizer	77.7	57.6
Glass	28.3	29.3
Iron & steel	11.6	13.1
Leather	3.9	4.0
Paint & varnish	38.1	37.0
Petroleum refining	28.9	28.7
Plastics	22.5	22.2
Pulp & paper	35.4	35.2
Rayon	21.0	20.7
Rubber	5.8	6.0
Textiles	8.8	8.5
Total	**298**	**280**

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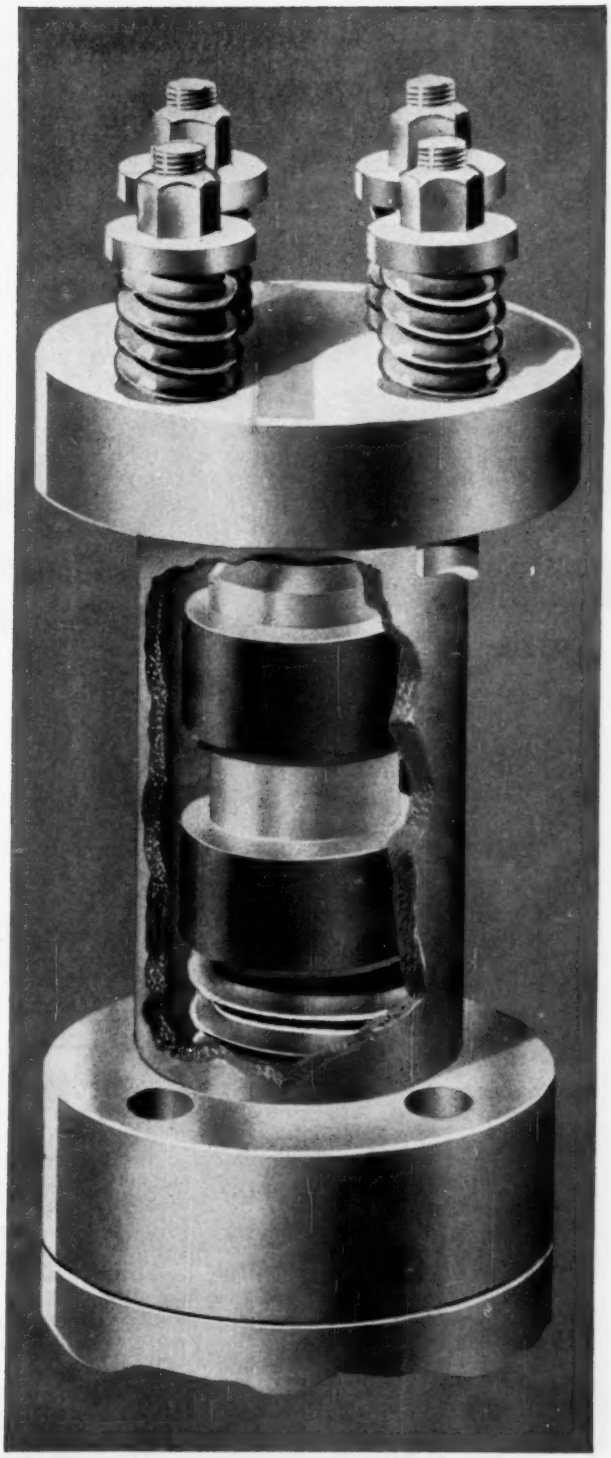

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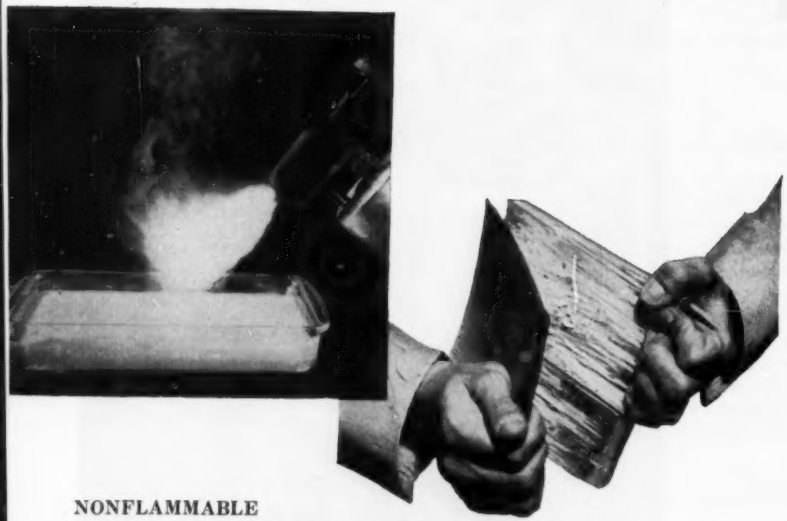

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Chlorinated Xylenes

Three new ones show promise as intermediates.

Already in pilot plant production of six chlorinated xylene compounds, Diamond Alkali is adding three more. One of the new products is derived from p-xylene, while the other two are m-xylene derivatives and represent the first chemicals to be offered by Diamond from this raw material.

They are terephthaloyl chloride, a derivative of γ, γ'-hexachloro-p-xylene, γ, γ'-hexachloro-m-xylene and its derivative isophthaloyl chloride. γ, γ'-hexachloro-m-xylene hydrolyzes to isophthalic acid, forms isophthalic esters through alcoholysis, and can be halogenated in the ring.

Both terephthaloyl chloride and isophthaloyl chloride can be reduced to dialdehydes and dibasic acids, can be oxidized to acids, and can be esterified easily with alcohols. They react readily with ammonia, amines and amino compounds. These acid chlorides will undergo the Friedel-Crafts reaction, will react with organic sodium compounds, with Grignard reagents, and can be chlorinated.

The high reactivity of the terephthaloyl and isophthaloyl chlorides makes them especially interesting as raw materials for interfacial polycondensation for preparation of polyamides and polyphenylesters.—**Diamond Alkali Co., Cleveland, Ohio. 68B**

Epoxides

Series of oxygenated chemicals not available before in commercial quantities.

More than 10 million lbs./yr. of new epoxides and other oxygenated chemicals will be produced in a new Institute, W. Va., unit to be completed by mid-1959.

Among the new products are Epoxide 201, vinylcyclohexene dioxide, vinylcyclohexene monoxide, dicyclopentadiene dioxide, styrene oxide, allyl epoxystearate, and caprolactone. These products are expected to play an important part in resin technology and to serve as chemical intermediates as well.

Special emphasis is to be placed on Epoxide 201 which forms plastics and coating resins of outstanding color stability and resistance to heat distortion. Chemically 3,4-epoxy-6-methylcyclohexylmethyl - 3,4 - epoxy - 6 - methylcyclohexanecarboxylate, it is more reactive to acid and anhydride hardeners than any other diepoxide.

Vinyl cyclohexene dioxide is a viscosity reducing agent for epoxy resins and performs its function without lowering the heat distortion temperature of conventional epoxy resins. Dicyclopentadiene dioxide forms resins of exceptionally high heat distortion temperature. Allyl epoxystearate can be used as a monomer.

In addition, two combination plasticizer-stabilizers for vinyl resins will be marketed. This marks the first time that all-synthetic materials have been available for this purpose. The new materials are di-2-ethylhexyl epoxy tetrahydrophthalate and di-isodecyl epoxytetrahydrophthalate. These materials are characterized by excellent stability and complete compatibility with vinyl chloride resins. —**Union Carbide Chemicals Co., New York, N. Y. 68C**

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Alcohols exist as free alcohols, fatty acids as free acids. Free alcohols can be reacted independent of the free fatty acids. Free fatty acids can be easily neutralized or reacted independent of the free alcohols.

In some reactions such as with ethylene oxide, both the fatty alcohols and the fatty acids react. It is possible to produce adducts with very low mole content of oxide and very low acid numbers, even less than 4.0

Emulsifiers, lubricants, superfatting agents, detergents, amines are among the reaction products of interest.—**Werner G. Smith, Inc., Cleveland. 70A**

Aircraft Paints

Five times brighter than conventional paint, eases plane spotting.

The Air Force plans to paint daylight-fluorescent markings on some 13,000 aircraft to increase their visibility. This is expected to lessen danger of mid-air collisions and make it easier to spot a plane that is forced down.

The bright orange markings —five times brighter than conventional color—will cover about 30% of a plane's surface.

The coating contains a resinous type of pigment in an acrylic binder, and the clear protective acrylic overcoating is fortified with materials that resist sun fading.

Reason for the brilliance of the paint is that it is a source as well as a reflector of color. The color absorbs shorter wave lengths and emits them as amplified color of a higher wave length. And light passes through the translucent paint and is reflected back through the film by the white undercoat.

The paint will stay bright for up to a year of outdoor exposure. It can be seen at distances up to 30,000 ft., unlike conventional color, which blends into gray or white at a great distance.

Fluorescent markings have proved successful in tests conducted by the Civil Aeronautics Administration, the Air Force and Navy. The CAA has adopted the color patches on all its planes.

The manufacturer foresees other applications for the paint, such as visibility markings on autos and speedboats. The paint has also been used on guided missiles, tow-targets, torpedoes and safety signs.—**Radiant Color Co., Oakland, Calif. 70B**

Paints

New metal protective compound, new chlorinated rubber paint.

A new metal protective paint that doesn't contain pigments or resins is now being manufactured.

With a zinc-silicate base, it will protect metals from atmospheric, sea water, fresh water, electrolytic, galvanic and carbon chemical corrosion.

The paint is said to resist a temperature as high as 1,000 F., and only two coats are necessary. — **MacLeaster Chemical Co., 16 Mill Lane, Carshalton, Surrey, England. 70C**

New chlorinated rubber paints which resist chemicals, water and fungus have been developed. They are superior to conventional chloride rubber paints because they can be applied as easily as oil bound colors. Drying time is about an hour.—**Corrosion Ltd., 16 Gloucester Pl., London W. 1, England. 70D**

BRIEFS

New use for Gilsonite, the natural hydrocarbon found in Utah, is a cold bituminous concrete for road surfacing. Called Gilsapave, it can be laid cold, even after the temperature drops below 35 F., the normal cutoff point for spreading hot-mix asphalt.—**American Gilsonite Co., Salt Lake City, Utah. 70E**

Bacterial inhibitor that will extend the life of soluble oil emulsions has been developed for the metal working industry. Called Elcide 75, it is a combination of thimerosal and solium-o-phenylphenate and is effective in all standard duty soluble oil emulsions.—**Eli Lilly & Co., Indianapolis, Ind. 70F**

Amphoteric surfactant called Miranol C2M Conc. is now available for both new steel drum manufacture and reconditioning of old drums. It is stable over the entire pH range in both muriatic acid and caustic soda as well as in other acids and alkalies.—**Miranol Chemical Co., Irvington, N. J. 70G**

Polypropylene price has been reduced by 7¢/lb. by both companies now supplying United States markets: Hercules and Italy's Montecatini. Price for natural resin is now 49¢ in truckload quantities.—**Hercules Powder Co., Wilmington, Del.; Chemore Corp., New York, N. Y. 70H**

New Dacron Type 64 is especially suited to blending with wool. Whereas standard Dacron Type 54 fiber is primarily in tightly constructed fabrics that have little surface nap, Type 64 makes possible the more loosely constructed fabrics. Resistance to pilling is an important area in which the new fiber shows marked improvement.—**Du Pont Co., Wilmington, Del. 70I**

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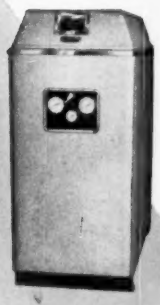

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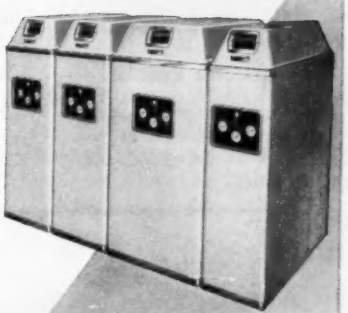

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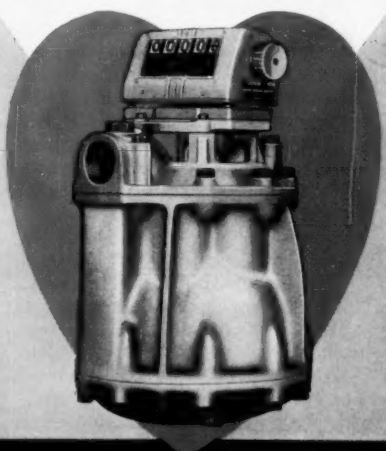

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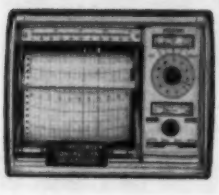
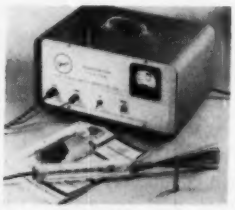
PROCESS EQUIPMENT EDITED BY C. C. VAN SOYE

Latest Developments



Electronic Controls

Manufacturer introduces all components of new line at ISA show. ***72A***

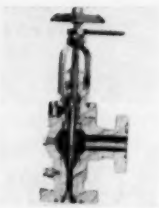


Glass Tester

Checks for flaws in surface of glassed-steel equipment. ***176A***

Fire Fighter

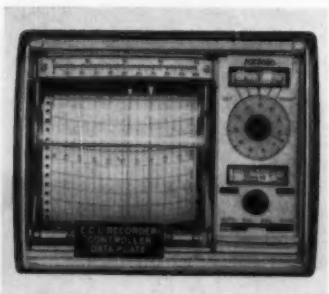
System remotely quenches dangerous blazes. ***177A***



Throttling Valve

Incorporates several desirable features. ***74A***

Page number is also Reader Service Code Number



Electronic Controls

Feature use of magnetic amplifiers, transistors.

Making its debut just three weeks ago at the Instrument-Automation Conference and Exhibit, Foxboro's Electronic Consotrol Instrumentation line consists of advanced-design transmitters, recorders, controllers and valve operators. Some of the line's features include: use of transistors and magnetic amplifiers; choice of motion-balance or force-balance transmitters; tubeless electrical measurement converters; and modified, semi-graphic control-station design. System explosion-proofing is optional.

In operation, pressure, flow and level measurements, converted at the transmitters to proportional d.c. signals, flow along unshielded lines to the control center. Converters for emf. and resistance measurements also feed signals to the small-case, panel-mounted receivers. Electrical controllers and final operators complete the loop.

Two-wire installation, narrow elevated ranges and compact construction characterize the force-balance transmitter. The motion-balance instrument provides field indication of measurement plus the opportunity to incorporate alarms, independent of transmitter power supply.

At the control-panel end of the loop, the line's one- and two-pen recorders with 4-in. strip charts offer compact, low-space design. Slide-out chassis with stretch-out cord permits recorder withdrawal without interruption of service. Deflection motors operate directly from the 10-50 ma. transmitted signals to drive the pens. Liquid dash pots limit pen disturbance and insure true average measurement.

Two controller stations are available. Model 62 universal controller has extra-wide adjustment ranges, while Model 61 is a simplified unit with adjustable proportional-plus-reset action especially suited to flow control. Neither unit uses vacuum tubes; both incorporate plug-in subassemblies for simplified maintenance.—**The Foxboro Co., Foxboro, Mass.** **72A**

Underground Insulation

Cost of underground steam lines cut by new method.

Savings of up to 50% over the cost of constructing buried steam lines by conventional methods are possible with a new system that eliminates need for concrete conduit and manholes. Key to successful application is the use of a compact expansion joint that excludes entry of the insulation material.

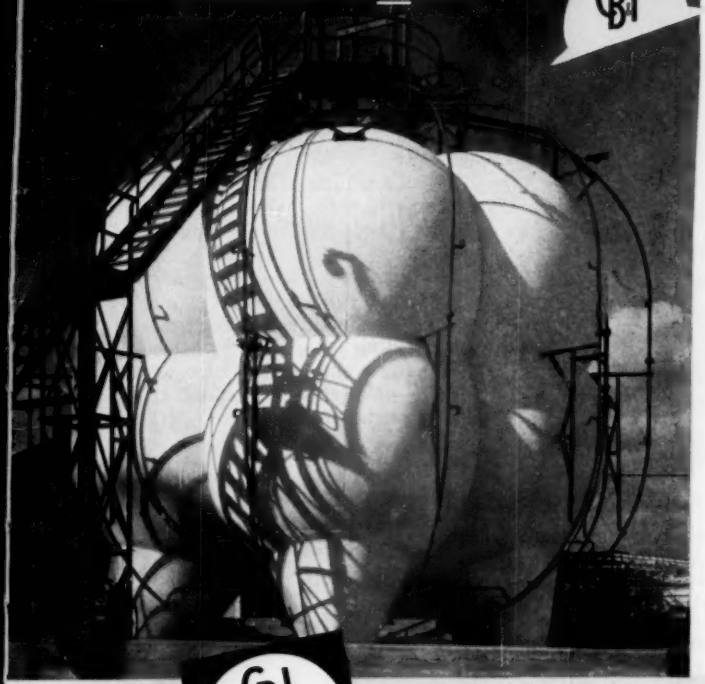
Installation procedure is as follows: once the trench is dug and pipe, expansion joints and fittings are laid, the work crew packs the line with a poured-in-place hydrocarbon insulation. As the line heats, the insulation cures to give a three-layer covering—plastic at the pipe, a sintered-consistency middle layer, and outer layer of loose granules. —**Badger Mfg. Co., Cambridge, Mass.** **72B**

Battery Charger

Vertical units require two-thirds less space.

Saving about two-thirds of the floor space needed by comparable horizontal models, a new, fully-automatic line of battery chargers provides users with a wide choice of electrical ratings. The

The containment of modern fuels and materials is both a business and an art with . . .



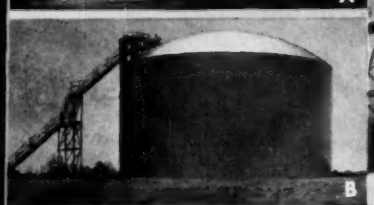
Chicago Bridge & Iron Company offers a complete and fully coordinated facility for the engineering, fabrication and erection of structures and vessels to contain and store modern fuels, chemicals and other process materials: in gas or liquid form, at high or low pressures, and at high or low temperatures.

Included in the CB&I Services are facilities for metallurgical control, stress-relieving, X-ray and welding—and techniques developed during nearly 70 years of service to industry. Five strategically located CB&I plants are staffed and equipped to serve your *specific* requirements for corrosion resistant metals for solid, lined or clad steel, alloy or non-ferrous construction.

A few typical installations are shown and described below. Of particular interest, is HORTON-CLAD®—a new vacuum bonding process which makes it possible for CB&I to produce composite plates in a larger range of combinations than has previously been available. Write our nearest CB&I office for the new bulletin on *Hortonclad* and literature on *CB&I Special plate structures.*

See for Creative CRAFTSMANSHIP IN STEEL

A



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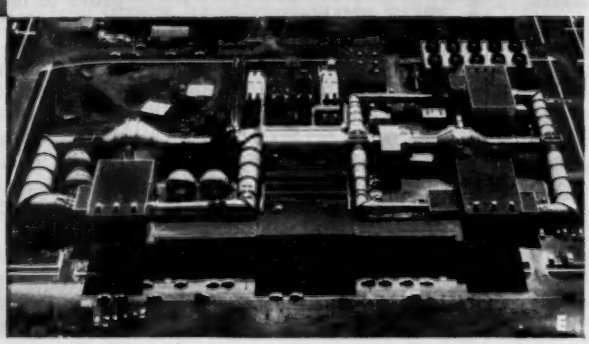


E

TOP, LEFT—14-lobe MULTISPHERE designed, fabricated and erected by CB&I to store 100,000 gallons of liquid methyl chloride at 150 lbs. working pressure. Design offers optimum versatility for pressure vessels.

A—5052 ALUMINUM was used for these ammonium nitrate storage tanks.

B—LIQUID PROPANE is stored by refrigeration at 1½ lbs. working pressure at minus 44° F in this unique 70-ft. diameter tank, designed and built by CB&I.

C—MULTICYLINDER Multi-lobe pressure vessels such as this offer advantage of high pressure storage where space is limited. Vessel is designed for 250 lbs. working pressure.

D—VACUUM SERVICE is provided by Hortonsphere® at a University of Toronto wind tunnel installation.

E—TUNNEL SECTIONS for wind tunnel were fabricated and erected by CB&I. A supersonic wind tunnel for Convair Division of General Dynamics was recently completed by CB&I as a "turnkey" project.

PRESSURE VESSELS • REFRIGERATED STORAGE • VACUUM SERVICE • HORTONCLAD® • ENGINEERING • FABRICATION • ERECTION IN ALL METALS AND COMBINATION METALS

Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston • Kansas City (Mo.) • New Orleans
New York • Philadelphia • Pittsburgh • Salt Lake City • San Francisco • Seattle • South Pasadena • Tulsa

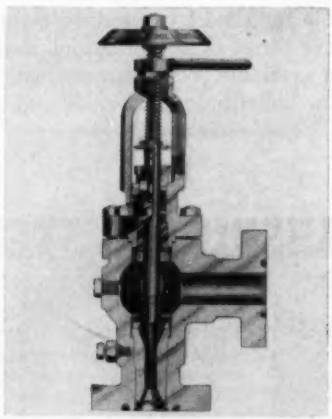
Plants in: BIRMINGHAM, CHICAGO, SALT LAKE CITY, GREENVILLE, PENNSYLVANIA and at NEW CASTLE, DELAWARE
In Canada: HORTON STEEL WORKS LTD., TORONTO, ONTARIO

Representatives and Licensees: Australia, Cuba, England, France, Germany, Italy, Japan, Netherlands, Scotland

E58CB

vertical motor-generator sets, also adaptable to off-floor mounting, feature parts standardization and simplification of design to produce substantial maintenance economies.

The units come in four different physical sizes, with a choice of 25 different ratings varying from 0 to 800 amp.-hr. Having 2-, 3- and 7½-hp. ratings, the chargers operate from a 2- or 3-phase, 60 cycle source at 220, 440 or 550 v.—**Exide Industrial Div., Electric Storage Battery Co., Philadelphia, Pa.** 72C



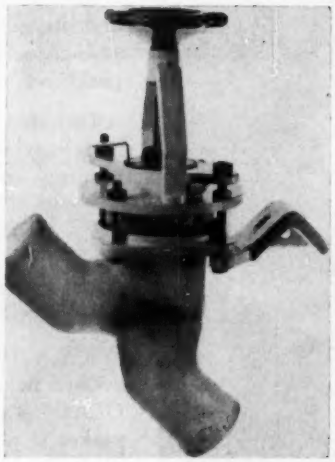
Throttling Valve

Oil-tool firm introduces valve for process use.

Ideal for accurate liquid or gas control, a new high-pressure throttling valve comes in sizes from 1 to 6 in. with flanged or threaded connections. Pressure ratings for all sizes vary to 10,000 psi. Automatic actuation by hydraulic or air pressure is available as an accessory for all valves.

Featuring outside threads for corrosion resistance, and a stem that locks at any setting, the valve also has a pointer and calibration plate to indicate orifice opening. Tapered throats give a venturi effect that results in excellent flow characteristics.

Several interchangeable tips provide service versatility: conical, micro tip (for linear change of orifice area), thermo tip (tip has internal heating element), and hardened tip for abrasion service. — **Shaffer Tool Works, Brea, Calif.** 74A



All-Glass Valve

Handles acidic fluids, all concentrations to 250 F.

Recommended for processing all acidic metallic salts, various crystalline slurries and all acids other than hydrofluoric and raw phosphoric, all-glass Y-type valves are now available from stock in 1½- and 2-in. sizes. The manufacturer plans to add both 1- and 3-in. sizes to the line in the near future.

All working parts exposed to fluids being handled are either glass or Teflon. Spring-loaded stems keep the plug tight when closed. For additional safety, a fiber glass sleeve forms a protective armor over the tempered glass body.

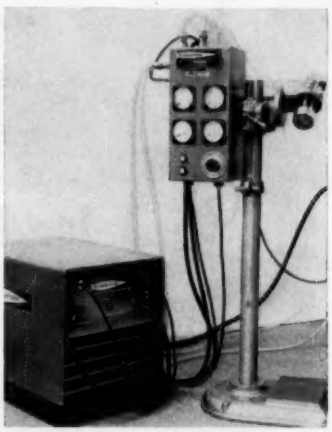
Low thermal expansion of the borosilicate glass allows sudden temperature differentials as high as 200 F. Maximum working temperature is 250 F.; maximum line presure is 50 psi.—**Corning Glass Works, Corning, N. Y.** 74B

Conveyor Scale

Pneumatic signals automate flow control.

Adaptable to either fixed- or variable-speed conveyors, a new unitized, pneumatic scale is available in a variety of sizes to handle a large range of capacities. Used in conjunction with the manufacturer's other weighing components, the scale can indicate, record, totalize, proportion or program material flow rate. Pneumatic signals from a transmitter control operation.

Unit installs easily on existing flat-belt or trough-type conveyors with a minimum of downtime and only slight conveyor modification. Instead of knife edges, pivots or bearings, the new scale employs a flexural frame arrangement. This eliminates all effects of side thrust and eccentric loading on the conveyor, delivering a single component of force. — **Weighing & Control Components, Hatboro. Pa.** 74C



Plasma Producer

Resultant temperature can vaporize any element.

Designed for creating and sustaining temperatures in excess of 22,000 F., the Plasmatron may prove to be a valuable new tool for research and, eventually, for production. A controlled jet of electrically neutral, partially ionized gas forms on passage through an electric arc in an enclosed chamber. Transfer of energy in the arc, accelerated by thermal and magnetic "pinch" effects, results in random motion among the ions and electrons, thus causing intense heat generation and the resultant high temperatures.

Plasmatron systems come in various power levels from 12.5 to 160 kw.—**Giannini Plasmadyne, Santa Ana, Calif.** 74D

Glass Tester
and other equipment news
on page 176.

BIG-DIAMETER PLASTIC PIPE?

YES...PLASTIC PIPE FOR YOUR PLANT UP TO 8" IN DIAMETER IS NOW AVAILABLE MADE FROM A-C POLYETHYLENE PIPE COMPOUND.

Now your plant can realize the advantages of plastic piping in large-diameter sizes as well as small. Plastic pipe—light, flexible, long lasting—can now be made up to 8" or more in diameter . . . with A-C Polyethylene Pipe Compound, the ultra-high-molecular-weight polyethylene.

More than 200,000 feet of this new pipe are already in use in chemical plants. Reports indicate substantial savings in installation, compared with metal pipe. Projected maintenance costs are phenomenally low. Unlike pipe made from conventional polyethylene, this new piping is completely free of stress cracking, splitting or pinholing. It has exceptional resistance to temperature variation, abrasion and corrosive chemicals.

The great strength of polyethylene pipe makes it ideal for maintenance applications. The smooth bore reduces flow resistance and prevents accumulation of deposits. How strong is it? In a typical test involving sudden surges of pressure, this pipe has withstood surges from 100-300 pounds per square inch for more than 90,000 cycles without failing.

ADVANTAGES of piping made with A-C Polyethylene Pipe Compound

Extraordinary chemical resistance. Withstands acids, alkalies, salts and detergents. Pure and inert for use with potable water.

Long service life. Will not rot, rust or corrode. Impervious to electrolytic environment. Good weather resistance.

Easy installation. Much lighter in weight than metal (about ⅛ the weight of steel). Long lengths readily joined by flanging, welding or Victaulic fittings.

No stress cracking. The only plastic pipe completely free from environmental stress cracking. Impact resistance of pipe compound is 13 ft-lb/in notch.

Surge resistance. Withstands pressures from 100-300 psi for over 90,000 cycles.

Good heat resistance. Greater resistance to temperature variation, hot or cold, than any comparable material.

Low cost. Below that of any metal pipe.

Sample lengths available to those who

Clip Coupon

to company letterhead.

Allied Chemical

SEMET-SOLVAY PETROCHEMICAL DIVISION

40 Rector Street, New York 6, N.Y.

Semet-Solvay Petrochemical Division, Dept. 108-E
40 Rector Street, New York 6, N.Y.

Please send me more information, including names of pipe manufacturers using A-C Polyethylene Pipe Compound.

Name_____

Position_____

Firm_____

Street_____

City_____ Zone_____ State_____

WHAT PROPERTIES DO YOU NEED IN VINYL PLASTICS?

Build them in with FLEXOL plasticizers!

The many different end uses for vinyl plastics each demand special properties. Each of CARBIDE's 15 FLEXOL plasticizers is designed to contribute one or more distinctive properties. Our technical representatives can help you select the plasticizer that will do your job best!

FLEXOL plasticizers DOP, 426, and 810 are designed to give an excellent balance of properties—good compatibility, low volatility, low-temperature flexibility, and superior electrical qualities. Other FLEXOL primary plasticizers have specialized properties. FLEXOL 10-10 possesses low volatility and good extraction resistance; FLEXOL 380 imparts outstanding lacquer mar resistance; and FLEXOL CC-55 has good viscosity characteristics and excellent fusing action in plastisols.

For vinyl plastics that must perform at extremely low temperatures, there are three special plasticizers, FLEXOL A-26, 10-A, and TOF. These are used to make vinyl plastics that are both impact resistant and flexible at temperatures as low as —70°C.

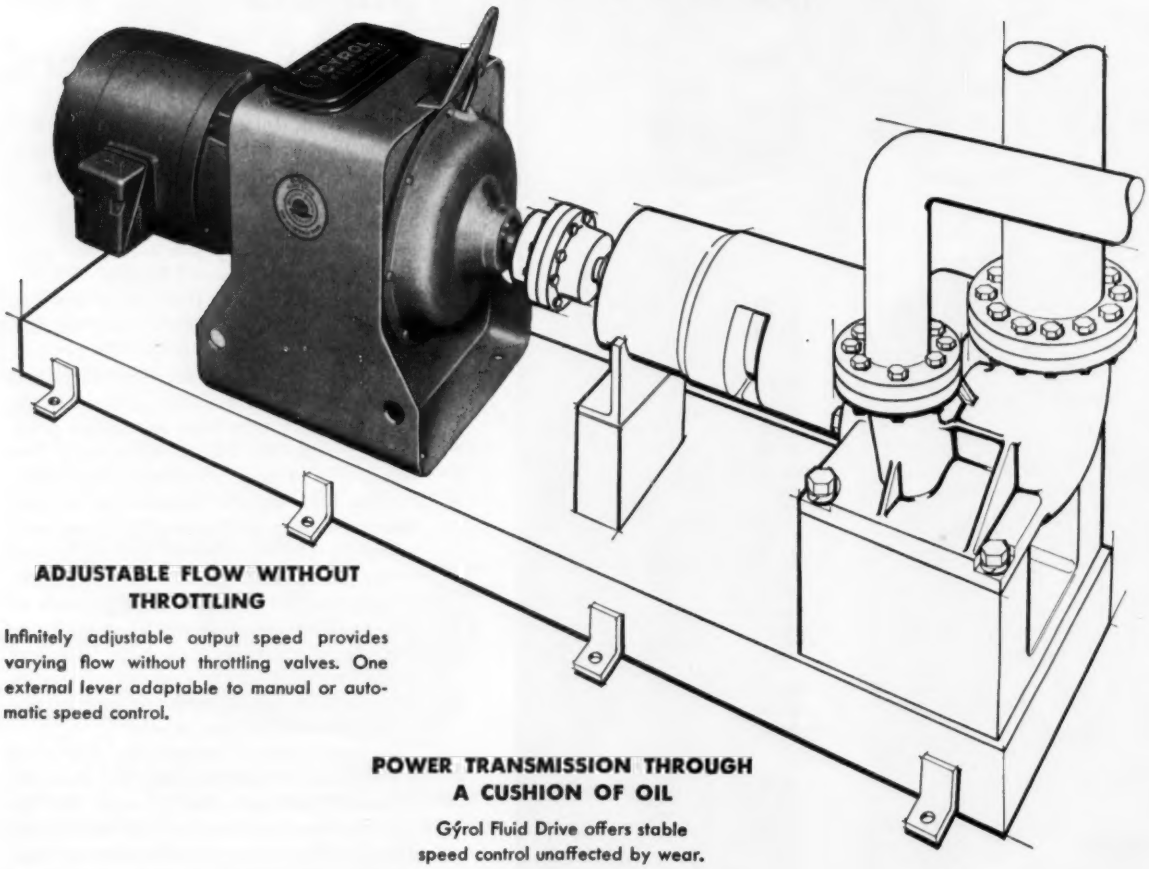
In some cases, CARBIDE has developed a plasticizer for a single use. For example, FLEXOL Plasticizer 3GH is used for the polyvinyl butyral interlayer in safety glass. This plasticizer increases adhesion and eliminates the need for edge sealing. Besides FLEXOL 3GH, CARBIDE produces six other special-purpose plasticizers, FLEXOL 3GO, 4GO, 8N8, R-2H, and B-400.

All 15 FLEXOL plasticizers are available from distribution points throughout the country. And, because of CARBIDE's wide variety of plasticizers, you can take advantage of the savings from combination tank car, tank wagon, and drum orders in LCL or carload orders. For more information on FLEXOL plasticizers, call the nearest CARBIDE office or write Department B, Union Carbide Chemicals Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, New York.

UNION CARBIDE CHEMICALS COMPANY

DIVISION OF UNION CARBIDE CORPORATION

American Blower *Gýrol*® Fluid Drive makes pumps more productive!



ADJUSTABLE FLOW WITHOUT THROTTLING

Infinitely adjustable output speed provides varying flow without throttling valves. One external lever adaptable to manual or automatic speed control.

POWER TRANSMISSION THROUGH A CUSHION OF OIL

Gýrol Fluid Drive offers stable speed control unaffected by wear.

Fact is, a Gýrol Fluid Drive can benefit any process requiring adjustable control of pump flow and pressure.

By providing *stepless speed control* without wasteful throttling, it reduces power consumption and pump work-load, keeps maintenance costs to a minimum. The problem of handling liquids at varying viscosity and density is greatly simplified.

With no mechanical connection between driving and driven shafts, adjustable speed is obtained without friction or wear. The smooth cushion of power-transmitting oil protects both driving and driven machines from shock. Torque-limiting capacity guards against overload.

Any standard pump driven by a constant-speed motor can be equipped with Gýrol Fluid Drive. Type VS, Class 2 Unit (shown here) comes in a complete range of sizes from 1 to 800 hp. Other designs handle up to 12,000 hp. So if you want to save power and reduce equipment and maintenance costs on pumping jobs that involve varying capacities . . . consider American Blower Gýrol Fluid Drive.

For full information, contact one of our 73 branch offices. Or write: American-Standard,* American Blower Division, Detroit 32, Michigan. In Canada: Canadian Sirocco products, Windsor, Ontario.

*American-Standard and Standard● are trademarks of American Radiator & Standard Sanitary Corporation.

AMERICAN-Standard
AMERICAN BLOWER DIVISION

YEAR 'ROUND BONUS!

You Get More Than Just a Valve When You Buy BS&B's Super 70

Specification of BS&B Super 70 Diaphragm Control Valves on your next job will assure you of getting all of the following:

1. High Quality Product . . . The BS&B Super 70 Diaphragm Control Valve has high efficiency and stability. In addition to thousands of hydraulic flow tests performed in the laboratory, analysis of operating data gathered from Super 70's on stream in customer plants substantiate their excellent performance.

2. Application Engineering . . . Today's complex processing problems require detailed analysis to determine proper instrumentation and control applications . . . accurate control valve sizing. This is a regular service to Super 70 customers.

3. Start-up Assistance . . . After helping customers select the right valve for a specific job, BS&B follows thru by assisting at plant start-up time.

4. Time-saving Scheduled Maintenance . . . With the patented clamp ring—float ring closure, valve maintenance can be done in a fraction of the time required by conventional type valves . . . an economic must in future valve specifications.

Clamp Ring — Float Ring Closure

Flanged — Gasket Closure

BS&B Super 70 Valves are available in either clamp ring—float ring, sealed bonnet or flanged-gasketed body closures. Whichever type you choose, when they're "on stream" you'll *know* that they're exactly right for the job.

Call your nearest BS&B office or representative now to discuss your present and future valve requirements. Or if you prefer, write for detailed information.

EFFICIENCY OVER 60 YEARS RELIABILITY BS&B

ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

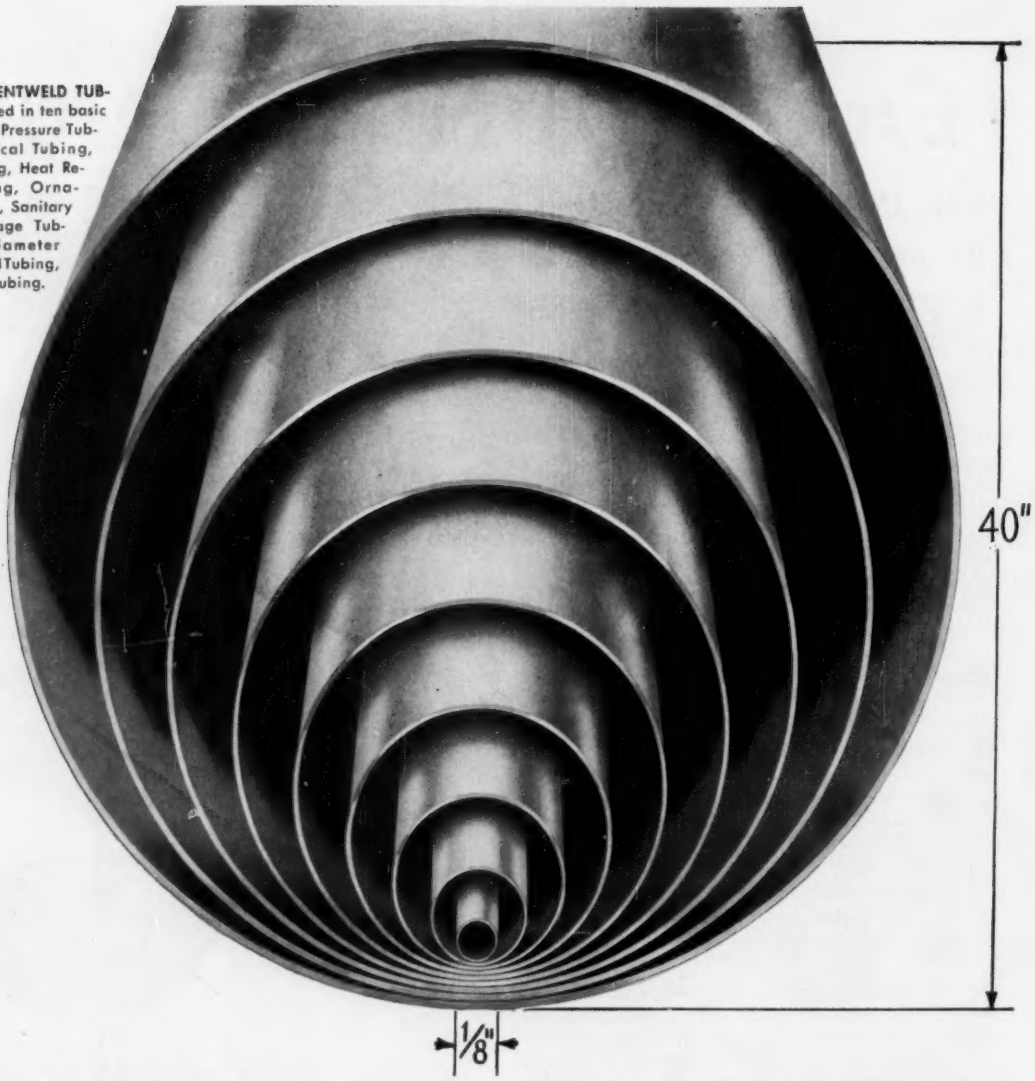
BLACK, SIVALLS & BRYSON, INC.

Controls Division, Dept. 4-N10

7500 East 12th Street

Kansas City 26, Missouri.

CONTOUR TRENTWELD TUBING is furnished in ten basic classifications: Pressure Tubing, Mechanical Tubing, Aircraft Tubing, Heat Resistant Tubing, Ornamental Tubing, Sanitary Tubing, Beverage Tubing, Large Diameter Tubing, Shaped Tubing, and Formed Tubing.



TRENTWELD tubing is equal in strength and has more uniformity than tubing made by any other method of manufacture

Trent offers tubing in sizes ranging from ⅛" to 40" O.D. and in a wide range of grades. These include: Hastelloy,* Zirconium, Zircaloy, Titanium and 19-9-DL grades. All are made by an exclusive welding process—Contour Trentweld®—which virtually eliminates the bead. Furthermore, by cold working and annealing after welding, Trent makes the weld equal in strength and corrosion resistance to the parent metal.

To insure that Trentweld tubing is of the highest quality attainable, a rigorous quality control program is carried out. Samples of each lot are tensile tested. Periodic tests — flattening, reverse bend, flare and flange, coil, and pressure — are conducted. Rigid corrosion tests are made on all lots intended for corrosive applications. When requested, a unique "single-wall" X-ray inspection is made as your final assurance of a sound, uniform product.

Why not take advantage of Trent *quality* when you order stainless or high alloy tubing? For further information, write for the Trent tubing handbook, Trent Tube Company, East Troy, Wisconsin.

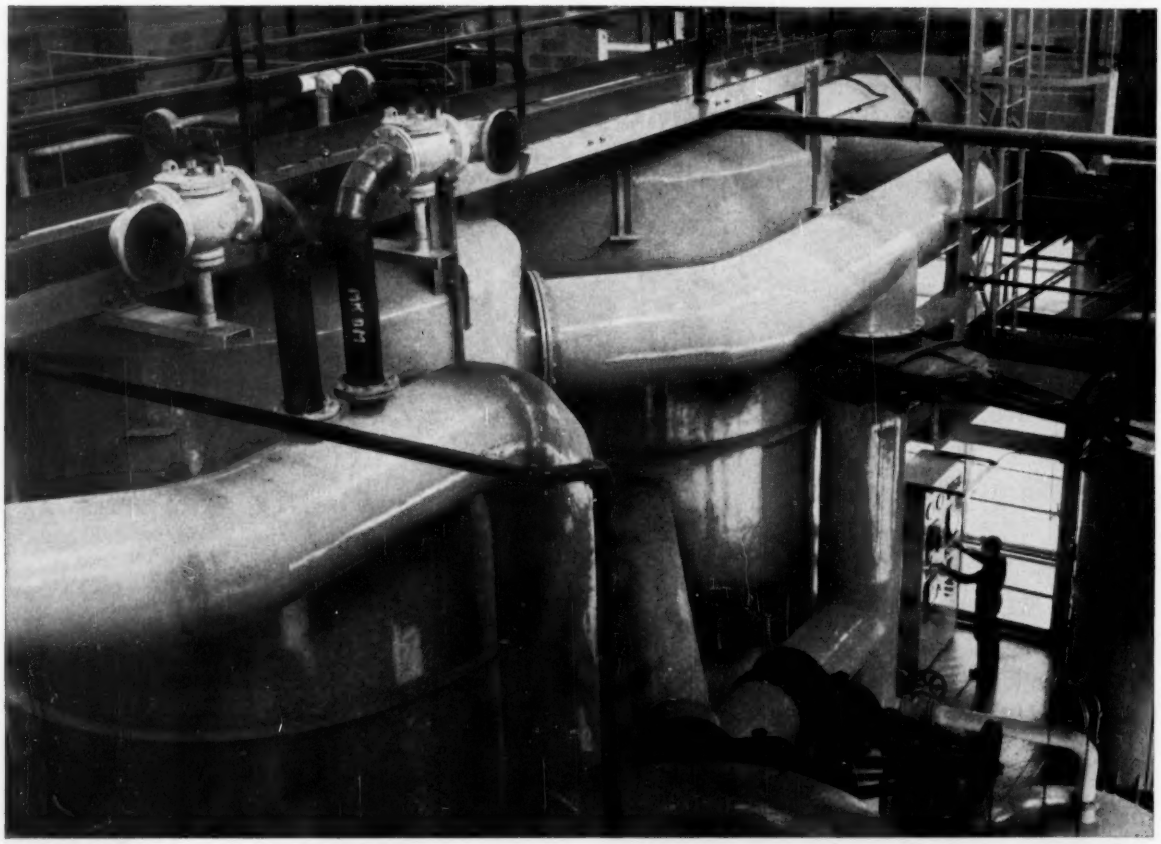
*Trademark of Haynes, Stellite Co.

CONTOUR TRENTWELD

TRENT TUBE COMPANY

Subsidiary of Crucible Steel Company of America

GENERAL OFFICES: EAST TROY, WISCONSIN
MILLS: EAST TROY, WIS.; FULLERTON, CALIF.



Evaporator bodies and vapor piping at the new $12 million chlorine-caustic soda plant of Hooker Chemicals Limited, No. Vancouver, B. C., are made of solid Nickel and Lukens Nickel-clad steel to guard against caustic corrosion, to assure product purity. Much of the equipment was supplied by Puget Sound Fabricators Inc., Seattle, Wash.

"Bodyguards"...Nickel, Monel alloy...prevent corrosion, metallic pick-up at Hooker's new caustic soda plant

To prevent caustic corrosion . . .

To safeguard product purity . . .

These are the principal reasons why Inco Nickel and Monel* nickel-copper alloy are used in the new chlorine-caustic soda plant of Hooker Chemicals Limited.

Equipment made of corrosion-resisting Inco Nickel and its alloys frequently gives more than a decade of service in handling strong caustic. Equally important, Nickel equipment has enabled producers to make millions of tons of caustic a year with less than 100 ppm of metallic impurities.

It will pay you to specify equipment of Inco Nickel, Monel alloy or Nickel-clad steel. Inco Nickel Alloys can be obtained in most mill forms right from warehouse stocks. (Listed under "Nickel" in your classified directory.)

Get complete technical data and service records. Write for "The Resistance of Nickel and Its Alloys to Caustic Alkalies." *Registered trademark

See how Nickel and Monel alloy are used in Hooker's new chlorine-caustic plant equipment

EQUIPMENT	MATERIAL	EQUIPMENT	MATERIAL
Caustic Tank	Nickel-clad steel	Salt receiver tanks	Nickel
Evaporator body	Nickel	Salt separator tanks	Nickel
		Barometric condenser	Monel alloy
Second effect vapor body	Nickel-clad steel	Cylinder coolers	Nickel-clad steel
Third effect vapor body	Nickel-clad steel	Cooling coils	Monel alloy tubing

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street New York 5, N. Y.

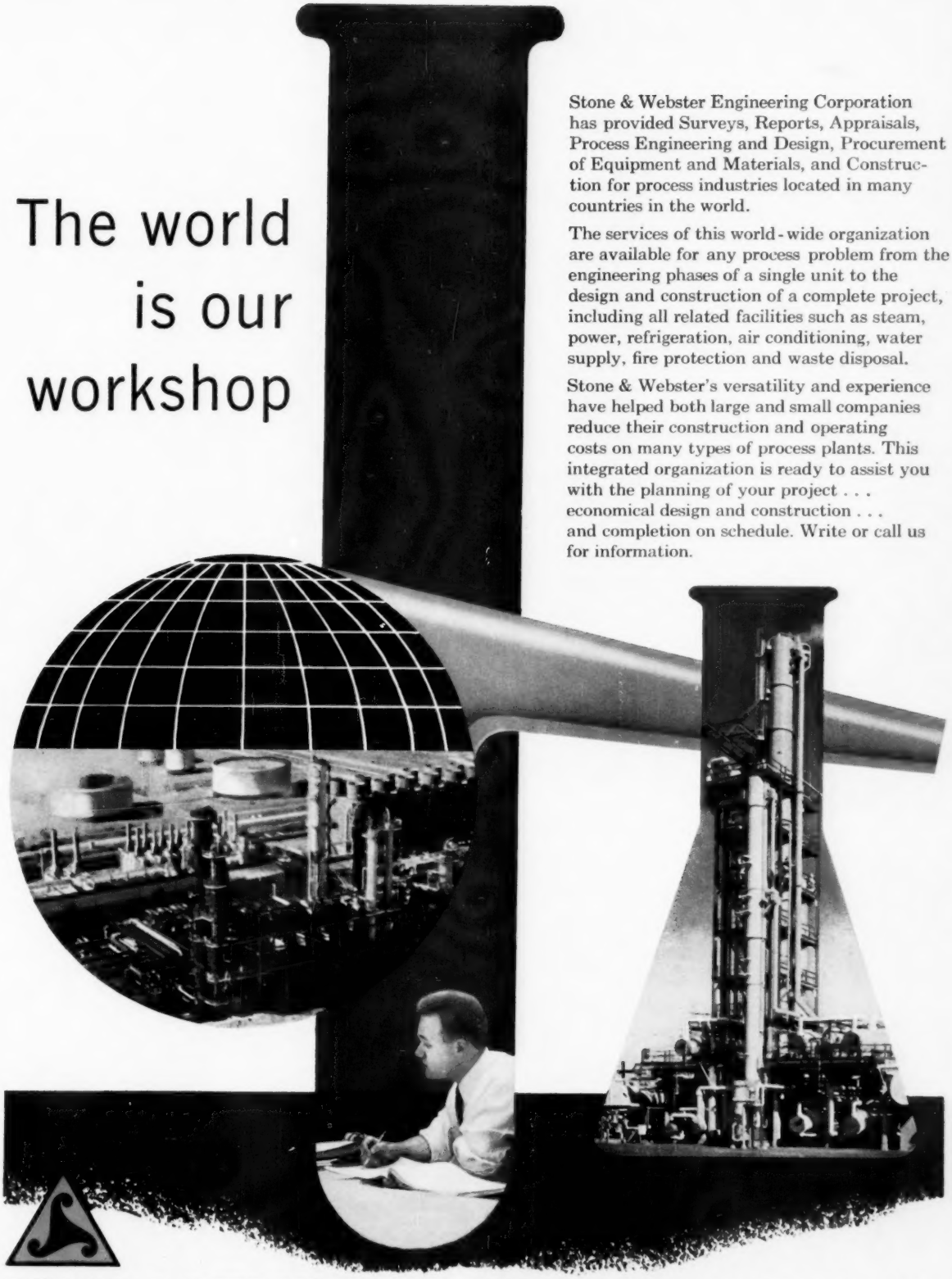
INCO NICKEL ALLOYS

The world is our workshop

Stone & Webster Engineering Corporation has provided Surveys, Reports, Appraisals, Process Engineering and Design, Procurement of Equipment and Materials, and Construction for process industries located in many countries in the world.

The services of this world-wide organization are available for any process problem from the engineering phases of a single unit to the design and construction of a complete project, including all related facilities such as steam, power, refrigeration, air conditioning, water supply, fire protection and waste disposal.

Stone & Webster's versatility and experience have helped both large and small companies reduce their construction and operating costs on many types of process plants. This integrated organization is ready to assist you with the planning of your project . . . economical design and construction . . . and completion on schedule. Write or call us for information.



STONE & WEBSTER ENGINEERING CORPORATION

AFFILIATED WITH STONE & WEBSTER ENGINEERING LIMITED (LONDON)

New York Boston Chicago Pittsburgh Houston San Francisco Los Angeles Seattle Toronto

with **DARCO®**

Activated Carbon

Decolorizing a valuable chemical often poses the problem of keeping all the chemical while you get rid of all the color. That's when the low product retention of DARCO Activated Carbon pays dividends.

Take the case of organic plasticizers for use in clear coatings, cements, plastics and other transparent products. Producers found that they could cut plasticizer loss in the filter cake in half by using high density DARCO—a decisive saving where the non-water-soluble chemical is tough to recover from the filter cake. And DARCO's high adsorptive efficiency adds low cost to high yield, making it economically attractive for clean-up jobs on many chemicals.

DARCO has been helping chemical manufacturers with purification for over 35 years. Chances are your problem is one it has already tackled—removing undesirable color bodies, odors, colloids, floc-precursors, or causes of haze or foam. On these . . . or on applications you may have just dreamed up . . . you can profit from our extensive know-how in adsorption. Call or write us today for data, samples or a consultation.

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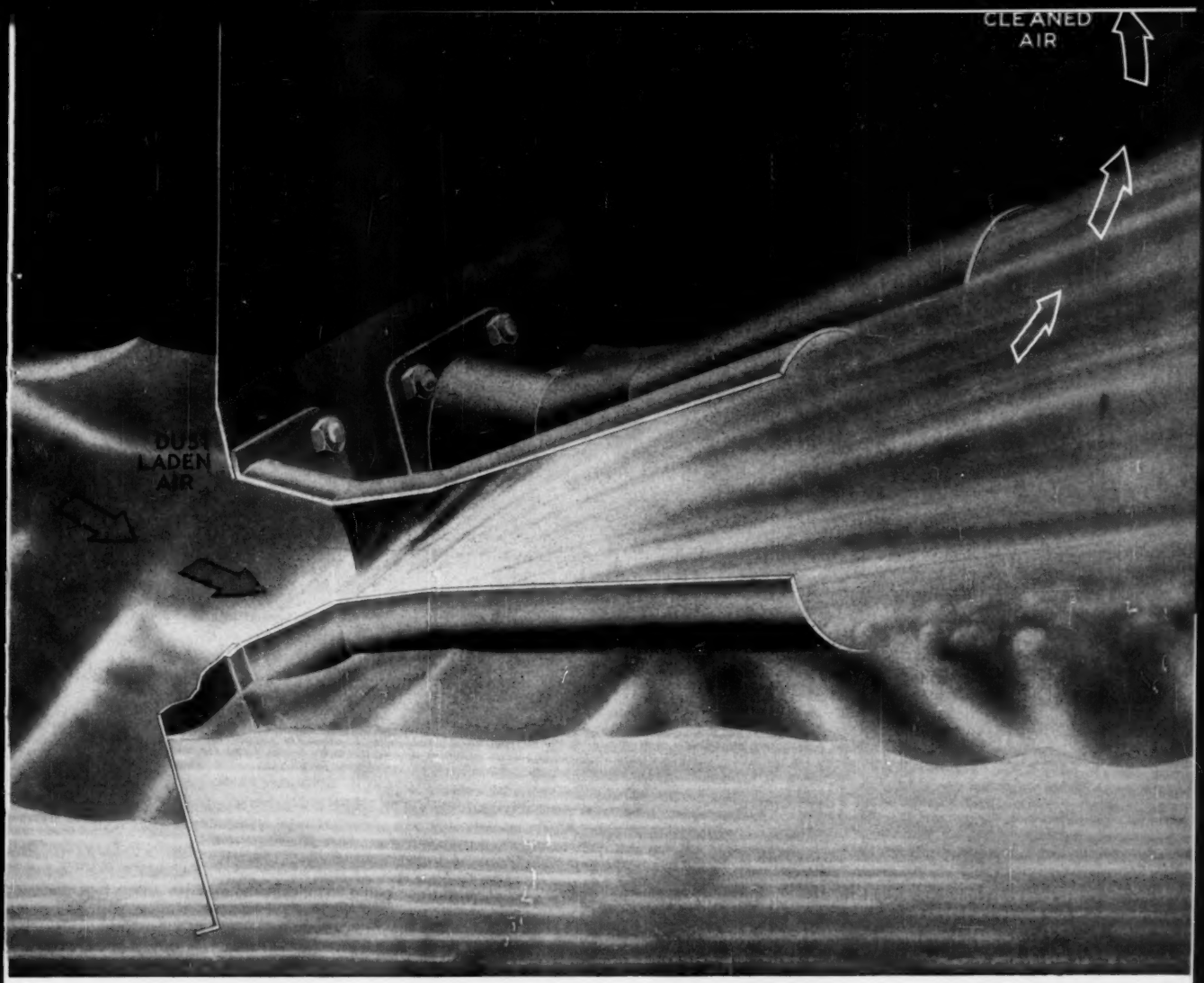


Puts the squeeze on difficult dusts

Pangborn Ventrijet Wet Dust Collector uses exclusive venturi tubes for peak efficiency

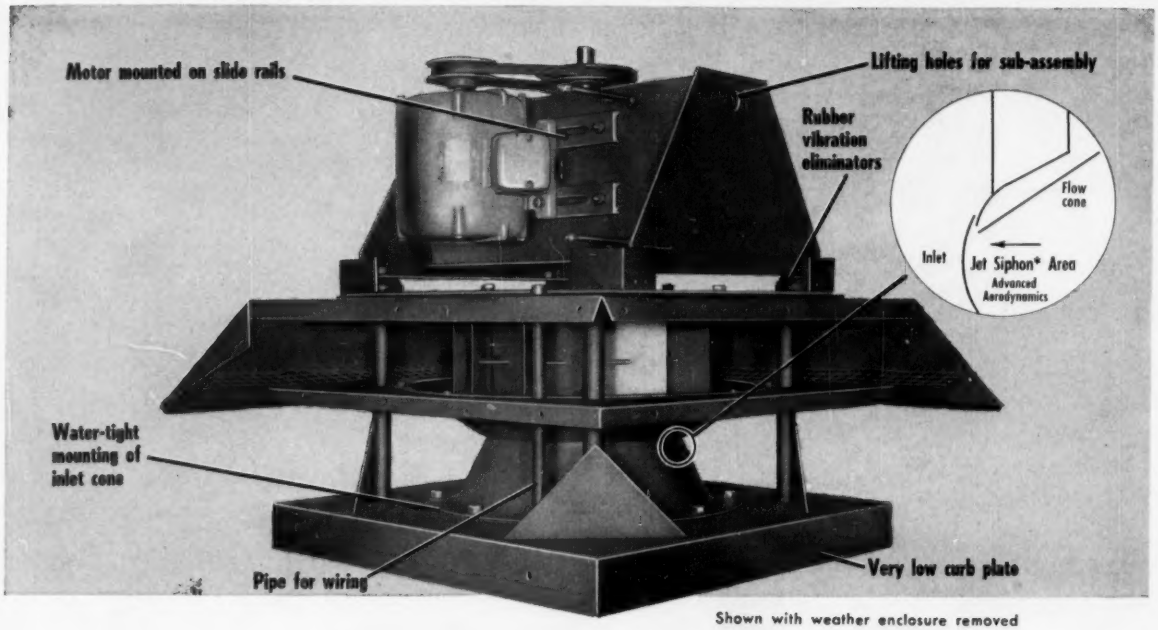
That pinch-necked venturi tube is the secret behind Pangborn Ventrijet performance. As dust-laden air flows through these tubes, the constriction creates a low-pressure area which draws water into the air stream. The resulting turbulence breaks the water into particles which actually *wash* the dust from the air. The simplicity of Ventrijet design saves money in its ease of installation, its low cost of operation and maintenance.

Although the Ventrijet is particularly suited to collecting hot, moist, inflammable, corrosive and obnoxious dusts, the Pangborn engineering it typifies is important to *any* dust-producing plant. It is not enough to put a dust collector within a plant. An efficient dust control system must be *scientifically* planned, designed and constructed to handle effectively a specific dust problem. This thinking is incorporated into every Pangborn proposal.

The Pangborn Engineer in your area will be glad to go to work for you. He is a dust expert *and will discuss your individual problem at no obligation. And, for more information, write for Bulletin 922 to:* Pangborn Corp., *2600 Pangborn Blvd., Hagerstown, Md. Manufacturers of Dust Control and Blast Cleaning Equipment.*

Pangborn Ventrijet Wet Dust Collector on the job. This is just one of Pangborn's comprehensive line of wet and dry dust collectors.

Pangborn CONTROLS DUST



Shown with weather enclosure removed

PLUS VALUES... all yours in the Clarage Centrilator

POWER ROOF VENTILATOR — CENTRIFUGAL TYPE

Jet Siphon* feature for stable, high efficiency.

Static pressures to 2" — thus well suited to both light-duty installations without ductwork and applications where ductwork or hoods impose considerable resistance.

Adaptable to a wide range of motor sizes.

Variable pitch V-belt drive.

Wheel and inlet designed for streamlined air flow.

Built heavy-duty throughout to assure long-lasting, trouble-free service.

Every wheel statically and dynamically balanced on precision machines.

Inspection panel and complete accessibility.

Low overall height.

Venting of motor and drive area.

Engineered and constructed for extra quietness.

Heavy-duty anti-friction bearings.

Simple installation — only 4 bolts required.

Write today for Bulletin 550. Clarage Fan Co., Kalamazoo, Mich.

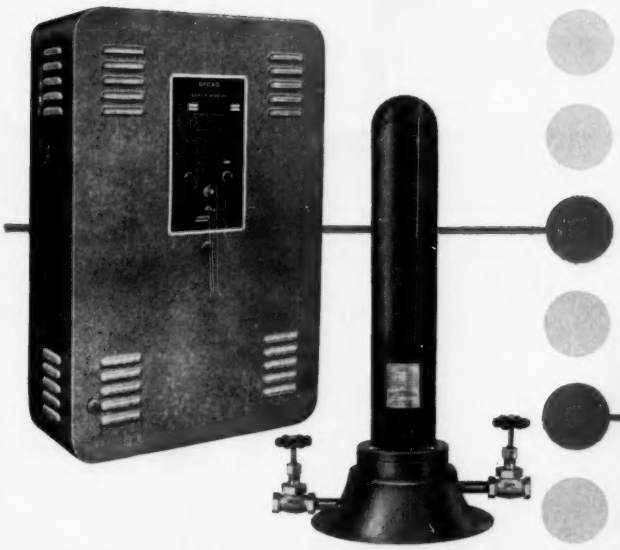
CLARAGE

*Patent applied for

...dependable equipment for making air your servant

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal

for low cost purification and drying of hydrogen and other gases



The Deoxo Catalytic Purifier is combined with an extremely efficient automatically operated drying unit to provide oxygen-free hydrogen that is ideally pure and dry. The combined units are identified as the Deoxo Dual Puridryer. It supplies hydrogen with less than one part oxygen per million — dried to a dew point of —100°F. *No inert gas purging is needed.* The Deoxo Dual Puridryer can also be used with other gases such as: Nitrogen, Argon, Helium and saturated hydrocarbons, with equally fine performance. Write for descriptive literature.

CHEMICAL DIVISION • 113 ASTOR STREET
NEWARK, N. J.

center for high purity fused quartz

Fused quartz laboratory and production equipment, including standard apparatus, crucibles, trays, cylindrical containers in a full range of sizes as well as tubing up to 25" diameter are available for early delivery. Amersil engineers are prepared to assist in developing fused quartz and silica equipment for special requirements. Send for brochure.

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for continuous measurement of traces of molecular oxygen in gases

In metallurgical and chemical processes requiring an oxygen-free atmosphere, the Minoxo Indicator provides a means of insuring that failure of purification or ingress of atmospheric oxygen through an unsuspected leak does not cause costly spoilage. The ranges covered are 0-10 and 0-100 ppm. High sensitivity and rapid speed of response recommend its use for both laboratory investigation and production quality control in a wide range of applications.

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ENGELHARD INDUSTRIES, INC.

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AMERSIL QUARTZ DIVISION

"SPECIAL" Welding Fittings

by MIDWEST

"SPECIAL" DESIGNS

"SPECIAL" MATERIALS

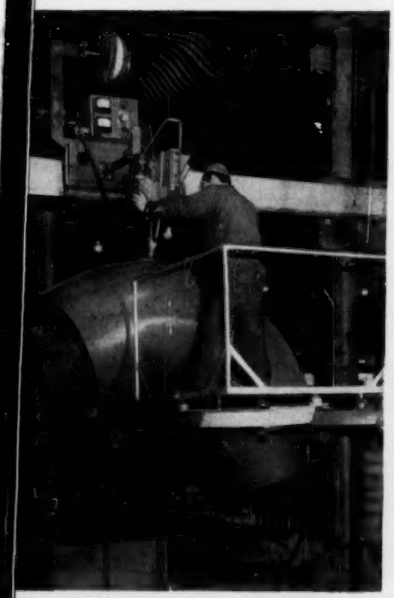
"SPECIAL" QUALITY

"SPECIAL" DELIVERY

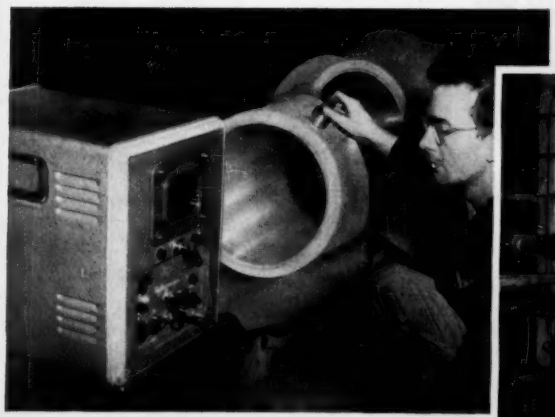
Special gauges and instruments are used to make sure that we have complied with the extremely close tolerances often required on stainless fittings. Here wall thickness and concentricity were held within extremely close limits throughout the fittings.

The exclusive Midwest method of manufacture—much more versatile and flexible than any other—enables us to make almost any type of special welding fittings to the most rigid specifications. Midwest makes welding fittings from *plate* . . . usually much easier to get than pipe, particularly if the material is special. That expedites delivery. Closer tolerances are inherent in the Midwest process, and quality control is always beyond code requirements.

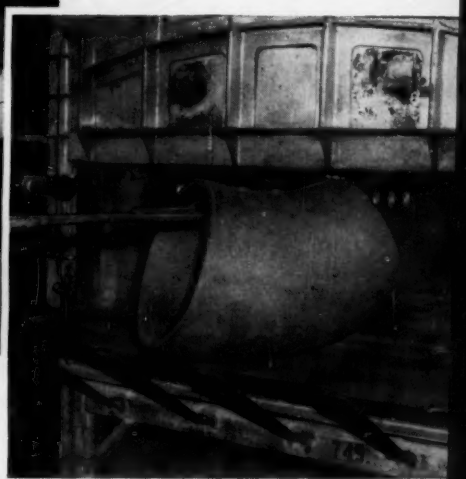
Even if you use only standard fittings, the exceptional quality of Midwest fittings can be important to you. Ask your Midwest distributor or write us for new Bulletin 5801.



36" O.D. 90° elbow with 16" tangent on one end being welded by an automatic submerged arc machine. Material is A-201 carbon steel.



Stainless-clad elbows undergoing ultrasonic inspection to check bonding of material and quality of weld. Since plate is often the only form in which clad material is available, the Midwest process is able to produce the most comprehensive range of clad fittings—and to do so promptly.



Special 24" x 21" 45° reducing elbow made of 1" thick 1¼% chrome ½% moly steel ready for heat treating furnace.

MIDWEST PIPING COMPANY, INC.

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PLANTS: ST. LOUIS, CLIFTON, N. J. and LOS ANGELES

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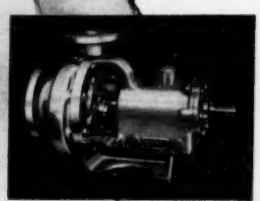
Pump Buyers are saying this about Peerless Process Pumps—



PEERLESS PUMPS

Putting Ideas to Work

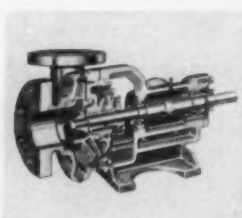
fmc FOOD MACHINERY AND CHEMICAL CORPORATION

Peerless Pump Division

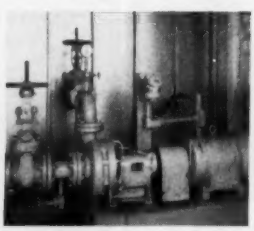
Plants: LOS ANGELES 31, CALIFORNIA and INDIANAPOLIS 8, INDIANA

Offices: New York, Atlanta, St. Louis, Phoenix, San Francisco, Chicago, Fresno, Los Angeles, Plainview and Lubbock, Texas, Albuquerque. **Distributors in Principal Cities.** Consult your telephone directory.

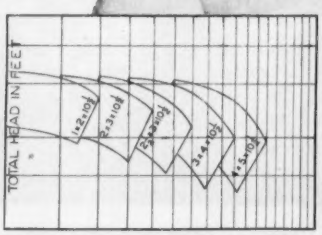
HERE ARE 4 CONVINCING REASONS WHY:



THEY OFFER the type of quality construction that measures up to any standard. Continual checking at every stage of manufacture guarantees the buyer performance he can count on in the field. *The best!*

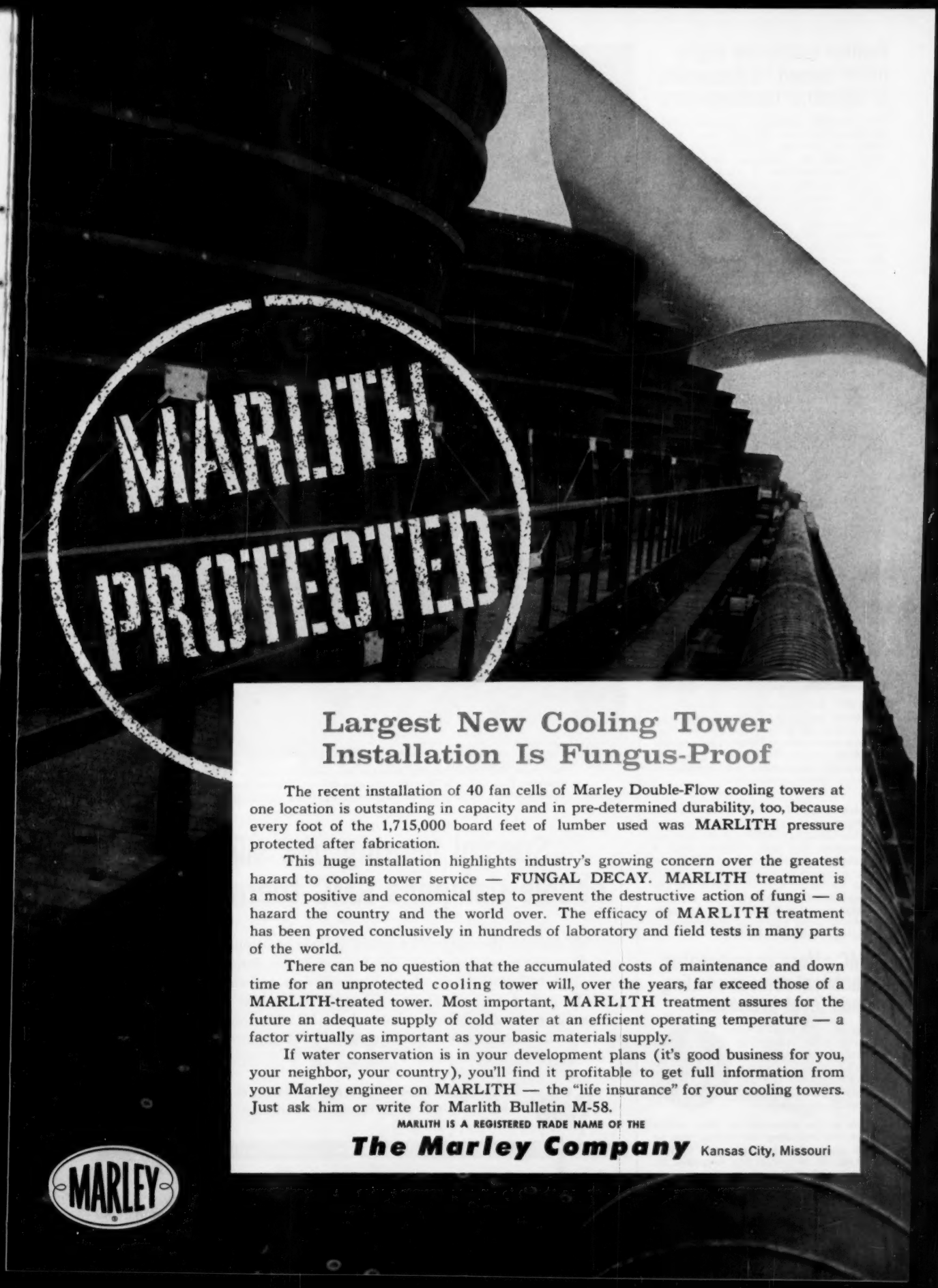


THEY PROVIDE the performance you expect and pay for, backed by actual operating records of Peerless pumps in installations like yours. Durability, dependability, efficiency—*all proved in service.*



THEY MEET *exactly* every pumping requirement, handle any job in your system that calls for a pump. The *complete* Peerless range offers *all* types of chemical process pumps, in *all* sizes and frames.

AN EXAMPLE of Peerless research is this recently released bulletin on the effects of radial loads in process pumps, "MECHANICAL CONSIDERATION IN PUMP DESIGN." Request Bulletin No. EM-79.



Largest New Cooling Tower Installation Is Fungus-Proof

The recent installation of 40 fan cells of Marley Double-Flow cooling towers at one location is outstanding in capacity and in pre-determined durability, too, because every foot of the 1,715,000 board feet of lumber used was **MARLITH** pressure protected after fabrication.

This huge installation highlights industry's growing concern over the greatest hazard to cooling tower service — **FUNGAL DECAY. MARLITH** treatment is a most positive and economical step to prevent the destructive action of fungi — a hazard the country and the world over. The efficacy of **MARLITH** treatment has been proved conclusively in hundreds of laboratory and field tests in many parts of the world.

There can be no question that the accumulated costs of maintenance and down time for an unprotected cooling tower will, over the years, far exceed those of a **MARLITH**-treated tower. Most important, **MARLITH** treatment assures for the future an adequate supply of cold water at an efficient operating temperature — a factor virtually as important as your basic materials supply.

If water conservation is in your development plans (it's good business for you, your neighbor, your country), you'll find it profitable to get full information from your Marley engineer on **MARLITH** — the "life insurance" for your cooling towers. Just ask him or write for Marlith Bulletin M-58.

MARLITH IS A REGISTERED TRADE NAME OF THE

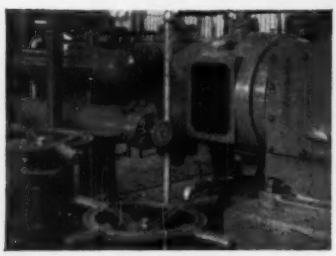
The Marley Company Kansas City, Missouri

MARLEY

Pointer oscillation only a minor reason for dampening of industrial thermometers

It is generally assumed that industrial thermometers are silicone dampened solely to prevent pointer oscillation when used on vibrating equipment. True, the prevention of pointer oscillation is necessary, but actually there are several far more important reasons for the use of silicone dampening fluids.

The primary reason for dampening bimetallic dial thermometers is to preserve accurate calibration, especially on the lower temperature ranges where a thinner bimetal element is used. An *un*dampened bimetal element, when subjected to shock or severe vibration, would have a tendency to unwind slightly, throwing the instrument out of calibration. To prevent this, thermometers are dampened by covering the bimetal element with silicone fluid. The silicone provides permanent protection for the critical bimetal element, holding the coil in place and preventing any unwinding or shifting action. This dampening, of course, also prevents pointer oscillation, eliminating difficult readings. But the primary reason for silicone dampening is to help maintain calibration accuracy, and it is therefore quite important to *all* industrial thermometer users.



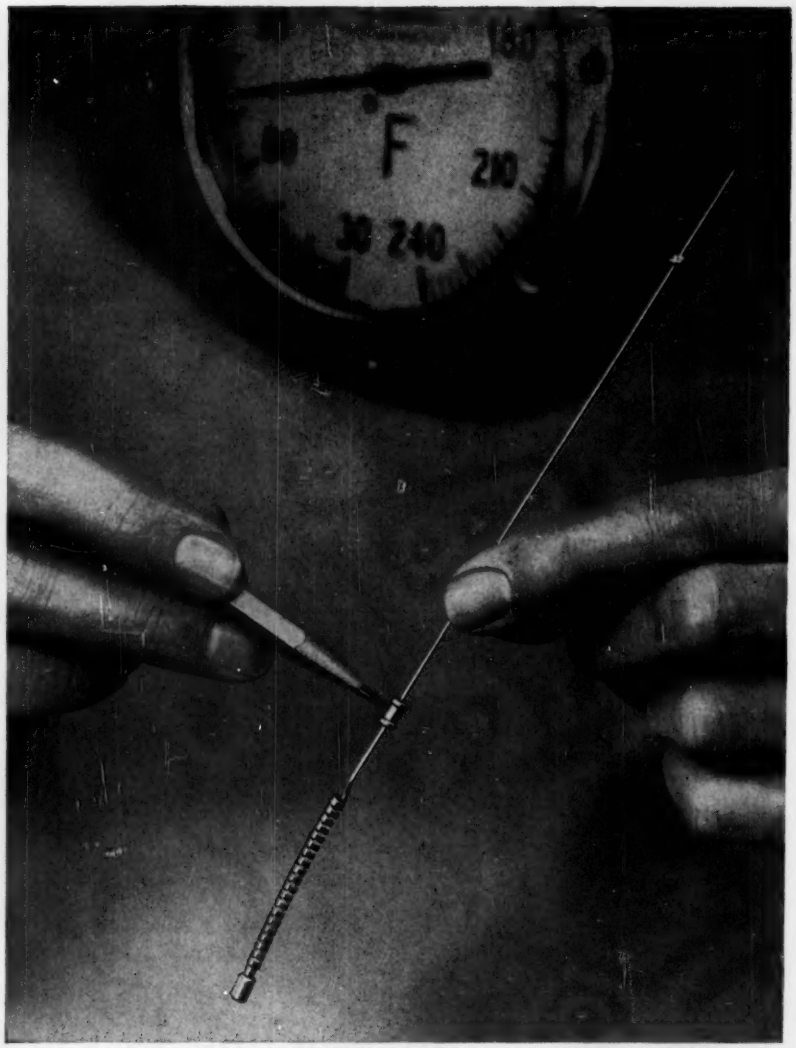
The RMC thermometer in this photograph is constantly subjected to extreme vibration. It is installed on a two-stage Synthesis Gas Compressor in Atlantic Refinery's Philadelphia Synthetic Ammonia Plant. Only a completely dampened thermometer could maintain its accuracy under such conditions.

There is more, however, to the full dampening story. Rochester Manufacturing Company carries this dampening procedure one step further with a specially designed bearing which further dampens both the shaft and coil. It also serves as a better guide for the bimetal shaft to keep it perfectly aligned within the tube. RMC is the only manufacturer using this type of dampening bearing at the present time.

RMC offers compensated electrical remote-reading liquid level indicator

A double coil movement in the RMC electrical, remote-reading liquid level indicator compensates for voltage changes. Silicone dampened and hermetically sealed.

Write, wire or phone—tell us your requirements for indicating instruments, and let RMC engineering skill go to work for you. ROCHESTER MFG. CO., 113 Rockwood St., Rochester 10, N. Y.



This special dampening bearing goes one step beyond silicone in the dampening of RMC thermometers. Only RMC uses this *extra* dampening device in addition to silicone and the usual stamped guide bearings. It is a precision machined part, serving several needed dampening functions.

Special bearing *plus* silicone double-dampens RMC thermometers

In RMC bimetal thermometers a specially designed dampening bearing is used just above the bimetal element. This bearing further dampens the shaft, helps to prevent coil unwinding and pointer oscillation, and also serves as a better guide for perfect shaft alignment within the tube. It's the combined use of this dampening bearing *and* silicone that makes RMC thermometers extra resistant to shock and vibration. You get this *only* in RMC industrial thermometers.

RMC

ROCHESTER MANUFACTURING CO., INC.
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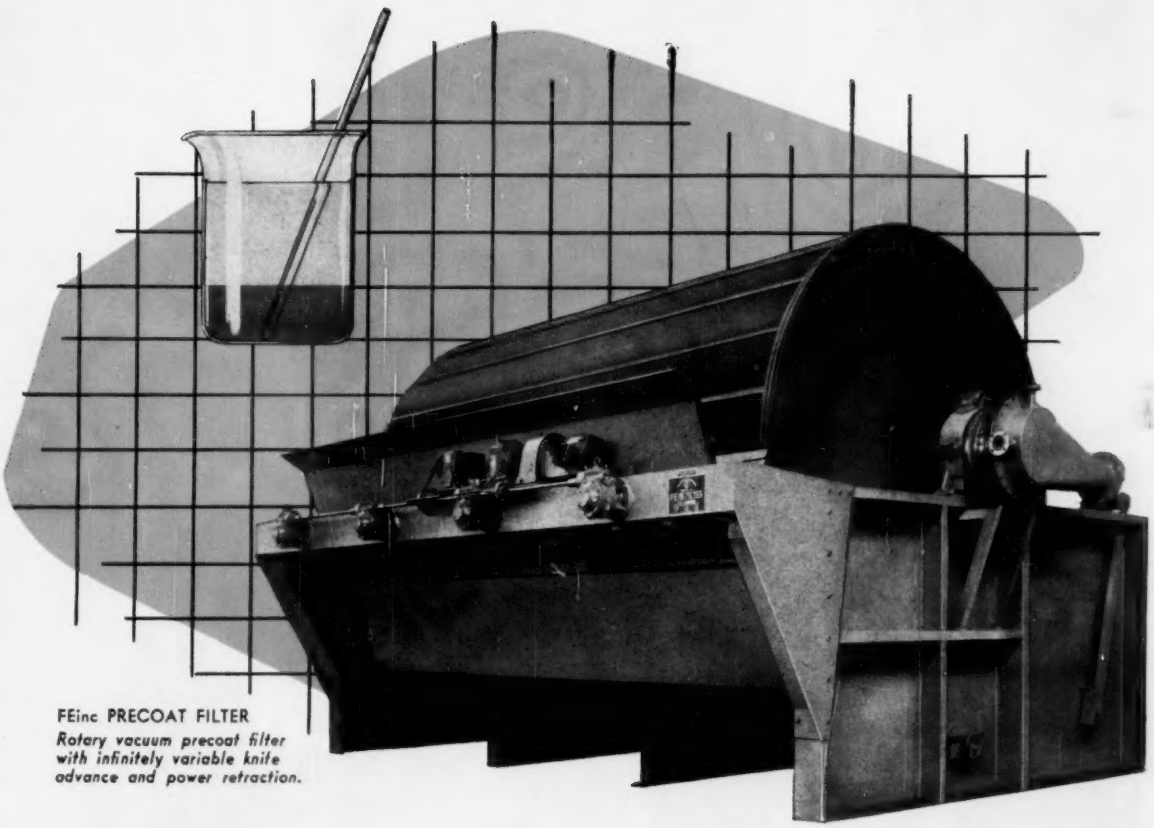
LIQUID LEVEL, TEMPERATURE and PRESSURE INSTRUMENTS

REPRESENTATIVES IN ALL PRINCIPAL CITIES



FEinc PRECOAT FILTER
Rotary vacuum precoat filter with infinitely variable knife advance and power retraction.

Custom Filter Design

BEGINS WITH YOUR FILTRATION PROBLEM

Your processing requirements are king at FEinc. They dictate the type of filter to be built, its size, the materials used, and the special refinements necessary to assure highest possible operating efficiency.

For example, a FEinc Precoat Filter designed to meet your particular needs pays off fast in trouble-free operation, dryer cake discharge and high clarity of effluent.

If you require higher output in limited floor area and a long filtration cycle coupled with the above advantages, FEinc *custom design* can give it to you.

Send us your filtration problems. Specific recommendations provided without obligation.

See our insert in Chemical Engineering Catalog.

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Large capacity . . . easily programmed and operated . . . mobile . . . low in cost

Compact, simple to use . . . Royal Precision LGP-30 brings high-speed electronic computation *right to your desk* . . . relieves you of the tedium of statistical analysis in such areas as research and product development, quality control and process control. And at the lowest cost ever for a complete computer system!

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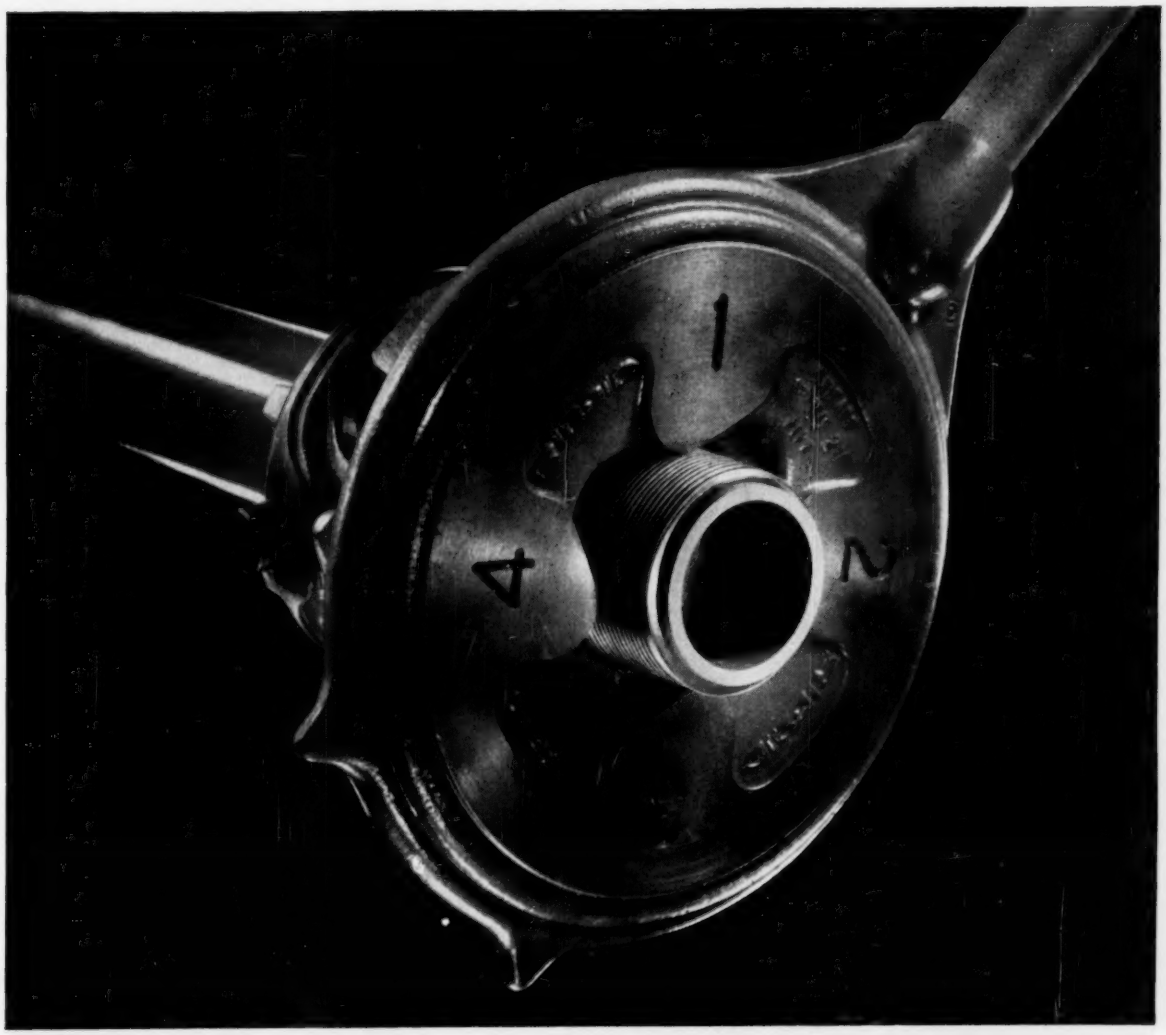
For further information and specifications, write Royal McBee Corporation, Data Processing Equipment Division, Port Chester, N. Y.

ROYAL McBEE

data processing division



Here's why saran lined pipe cuts installation costs

It's easy to fabricate, easy to install at job site . . .
and it resists corrosion for years

Here is a corrosion-resistant pipe that can be fabricated in the field. Saran lined pipe can be cut and threaded at the job site with conventional hand tools or power equipment. And, once installed, saran lined piping systems resist corrosion for years . . . offering proved long-range economy.

For piping acids, alkalies, solvents and other corrosive fluids specify saran lined pipe, fittings, valves, and pumps with the new gray lining. This new lining anchored under pressure within the steel casing, enables you to pipe fluids over a wider range of temperatures than ever before . . . with maximum protection from corrosion, plus the strength of steel.

Saran lined pipe, fittings, valves, and pumps are available for systems operating from vacuum to 300 psi, and from well below zero to 200°F.

If your operation can benefit from a *complete* corrosion resistant piping system, write today for more information about saran lined piping components. And be sure to ask about Saraloy® 898 tank lining, too! THE DOW CHEMICAL COMPANY, Midland, Michigan.

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DEPT. 2001A-2
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Please send me information on: ☐ Saran lined pipe, fittings and valves. ☐ Saran lined centrifugal pumps. ☐ Saraloy 898 chemical resistant sheeting.

Name_____ Title_____ Company_____

Address_____ City_____ State_____

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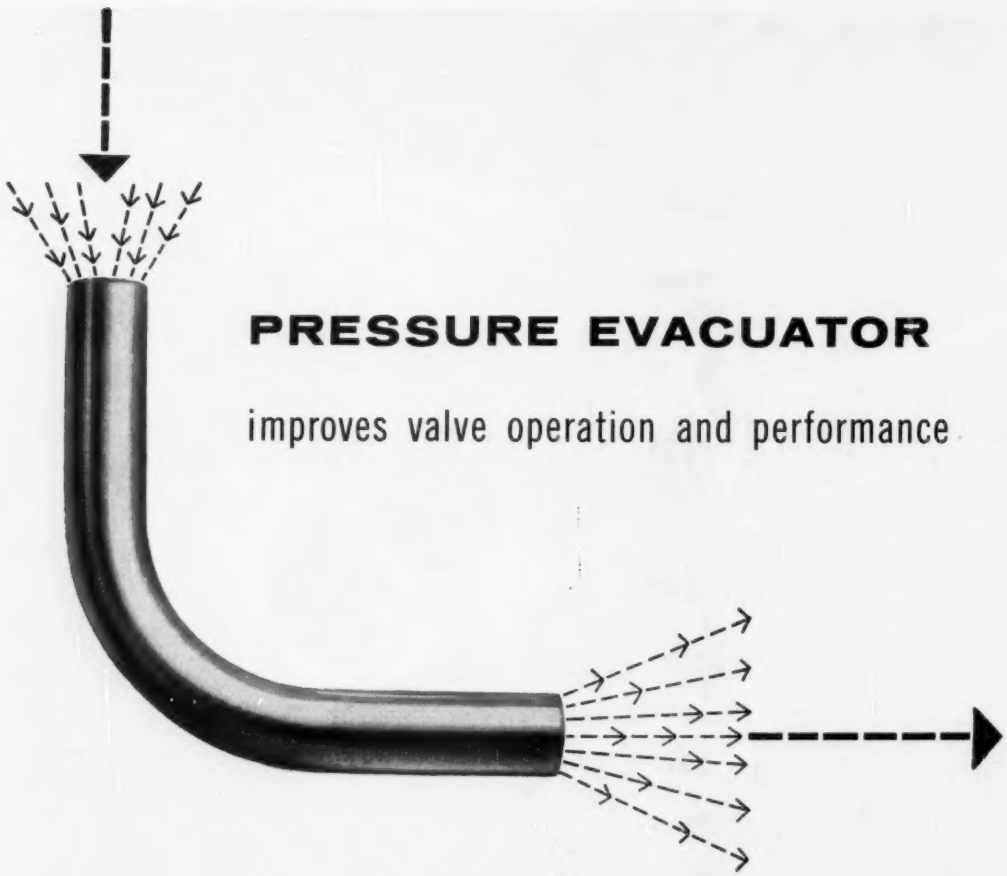
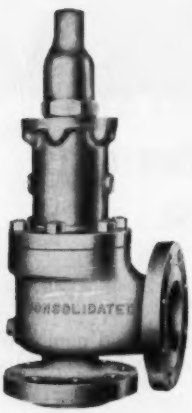


PRESSURE EVACUATOR

improves valve operation and performance



Consolidated Safety Relief Valve, Type 1900 Series, Sizes: 1" x 2" to 8" x 10".

The Eductor Tube in Standard Consolidated Safety Relief Valves is a pressure evacuator. It efficiently removes pressure from the closed bonnet. If allowed to remain in the bonnet, the pressure would act on the top of the disc and tend to limit the lift and induce cycling. But with the pressure evacuated from the closed bonnet through the Eductor Tube, the spring alone controls valve action. Consequently, *reliable* valve action and guaranteed capacity ratings are attained. A new high in operational dependability is assured.

Reliable operation and performance of Consolidated Safety Relief Valves are your assurance of absolute protection for personnel and equipment. "2 in 1" design permits you to convert the Standard valve to the Bellows type in your own shop. But that is only part of the total economy of these modern valves. Get the complete inside story. Write for Catalog 1900.

MANNING MAXWELL & MOORE INC. TRADE MARK

CONSOLIDATED SAFETY RELIEF VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Tulsa, Oklahoma

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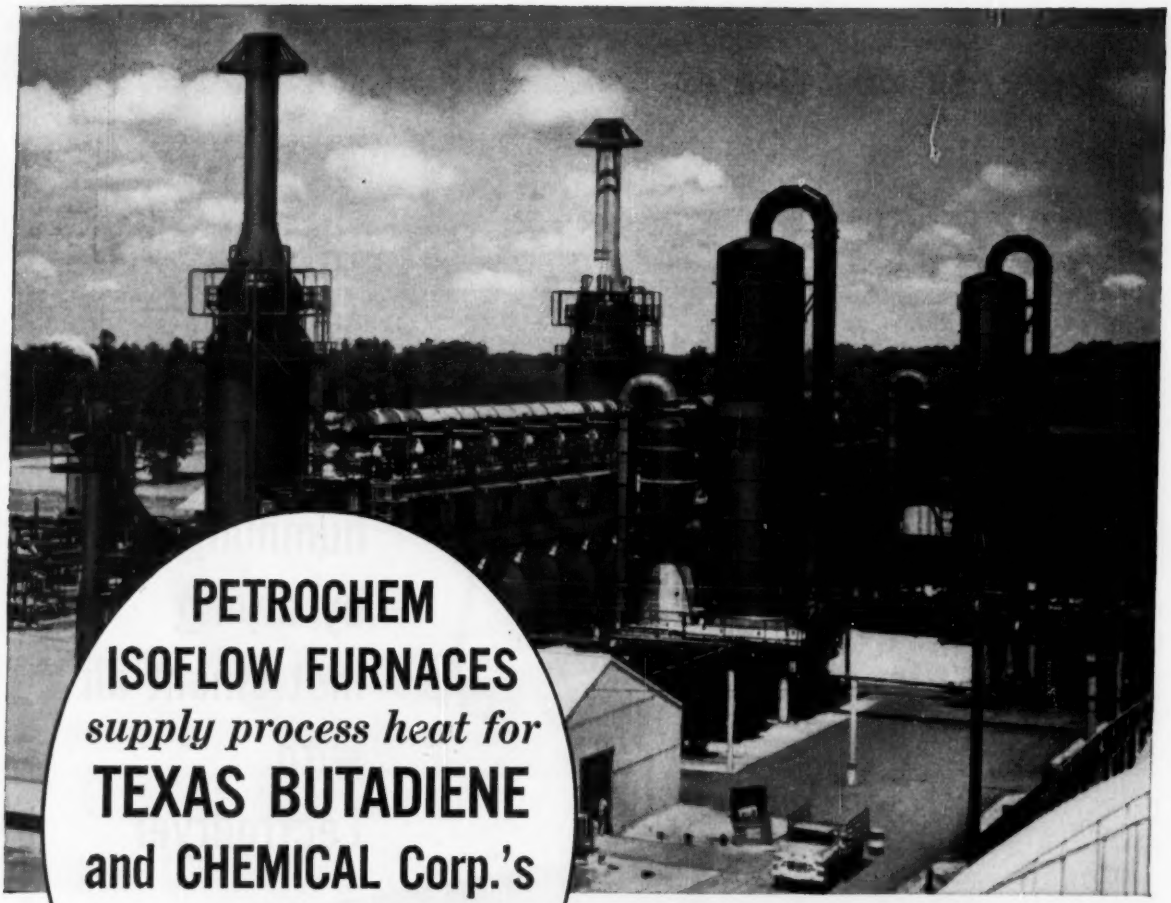

PETROCHEM ISOFLOW FURNACES *supply process heat for* TEXAS BUTADIENE and CHEMICAL Corp.'s 86,000 TON BUTADIENE PLANT

. . . in fact, approximately 85% of all new butadiene capacity in the U.S. is processed through Petrochem "Isoflows."

The unique design and operating features which have led to the wide acceptance of Petrochem Isoflow Furnaces for butadiene production, catalytic reforming and other petroleum, petrochemical and chemical processes include:

• Uniform Heat Distribution • Maximum Fuel Efficiency • Low Pressure Drop • Low Maintenance • Zero Air Leakage • Minimum Ground Space • Simplicity of Design and Construction • Short Length of Liquid Travel • Series, Multipass, all parallel flow • Excess Draft for High Overload

There's a Petrochem Isoflow Furnace for any duty, temperature and efficiency.

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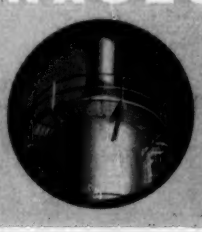

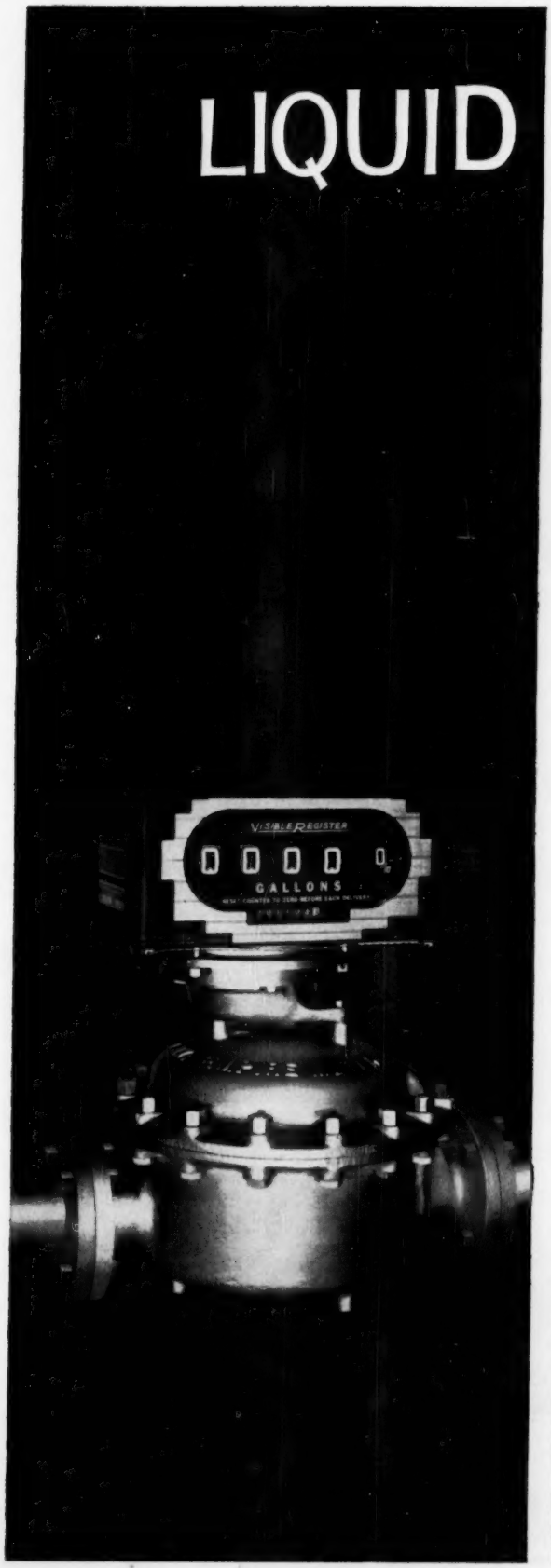

LIQUID METERING

CAN BE SIMPLE, INEXPENSIVE . . .

and Save You Money!

Perhaps you've felt the need to meter your industrial liquids but have hesitated because you feared metering was costly or complicated. Actually, even a plant-wide installation of simple, direct reading Rockwell meters can be made very easily and for a nominal investment. They will pay their way many times over by providing realistic records for cost, inventory and utilization controls.

Measure Even Corrosive Liquids. Among the many types of Rockwell meters, there is the right design to measure most anything that flows . . . including *all stainless-steel meters* for corrosive liquids.

If you blend, batch or package liquids, Rockwell meter accessories such as automatic shut-off controls, impulse counters and remote registration will cut your costs and increase production. Use the coupon for full details.

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another fine product by

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Pittsburgh 8, Pa.

Gentlemen

I am interested in measuring _____
(Name of Liquid)

Pipe Size _____"

Working Pressure _____ psi Temperature _____ °F max.

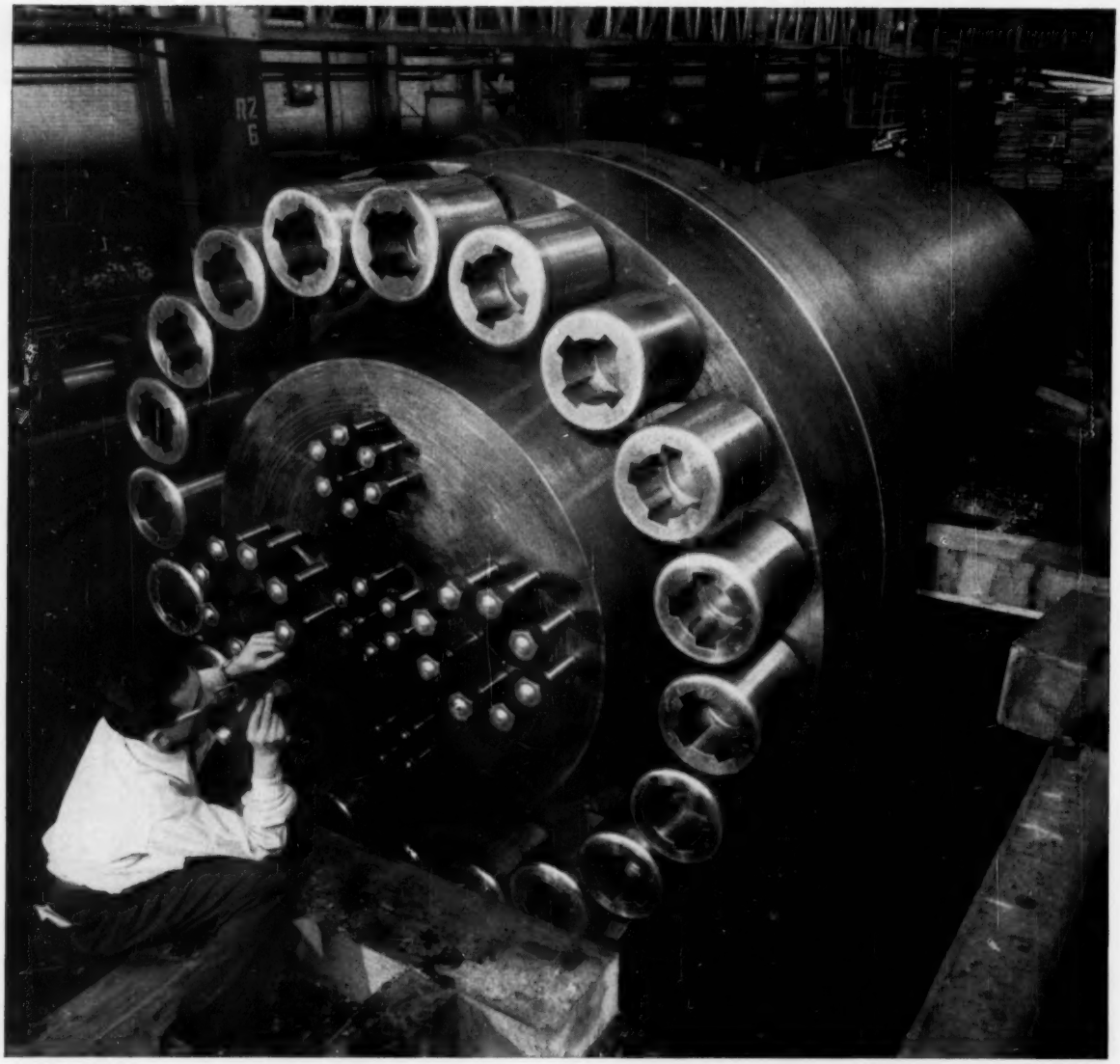
Max. Flow Rate _____ gpm Min. Flow Rate _____ gpm

Your Name _____

Company _____

Street _____

City _____ Zone _____ State _____



Big Separator Ready to Go

Here's a 43-ton forged-steel separator built recently in the Bethlehem shops. It's 14 ft long and has an ID of 48 in. Note the massive head and those tremendous closure nuts. Everything about this vessel has the ruggedness and strength needed to handle high pressures.

The unit is typical of the many seamless vessels that Bethlehem custom-builds for the chemical industry. We are equipped to forge, treat, machine, and assemble virtually any type of separator, filter, reactor, converter, autoclave, or accumulator—in weights ranging from a few hundred pounds to 150 tons. No matter how small or how large, all Bethlehem vessels are made to exacting standards, with every specification met in full.

When you are planning new equipment of this nature, we suggest you discuss it with our engineers. They know all aspects of the technical problems involved, and you can rely upon them for complete cooperation.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by
Bethlehem Pacific Coast Steel Corporation
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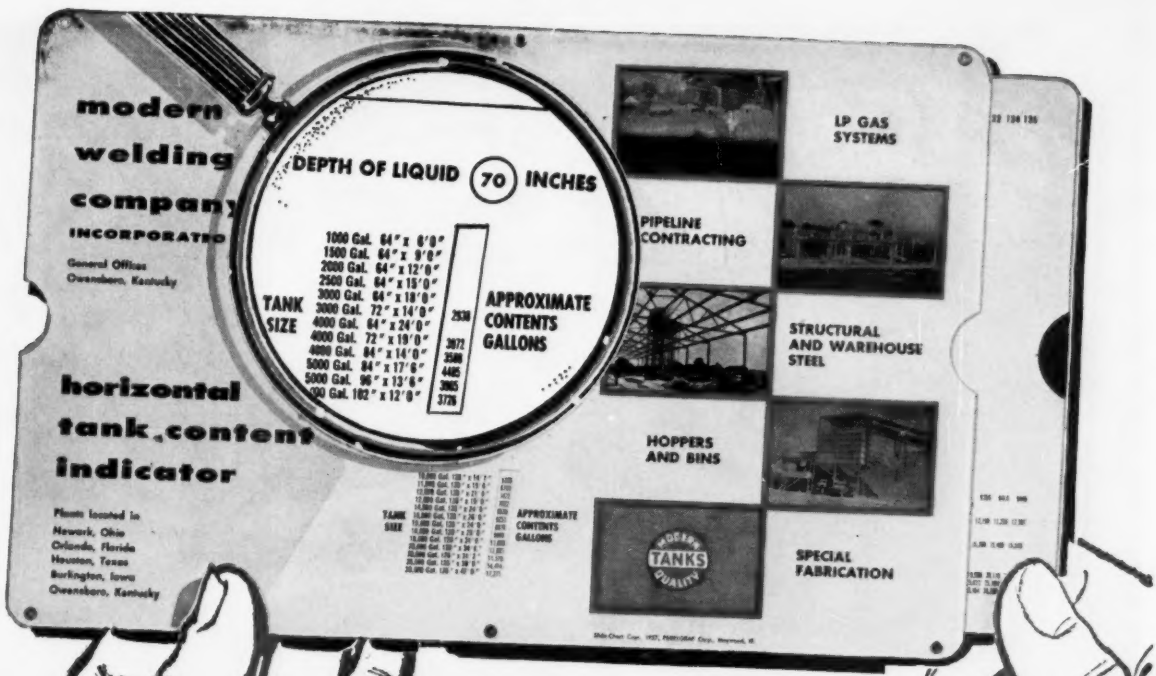
BETHLEHEM STEEL

BETHLEHEM STEEL



Yes, efficient storage is our business:

And efficient storage includes accurate inventories. To help you with these records, a new **"Modern Liquid Computor"** is available *absolutely free.* There are many other ways **Modern** can help you plan for more efficient and economical storage. Just write or phone. A **Modern** representative will "come a-runnin' ".

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EXTRA WORK PER HOUR. No matter what bulk you handle, you'll get more productive work at less cost with the new Yale Industrial Tractor Shovel. *It carries more*—full 2500-lb. bucket capacity. *It moves faster*—accelerates to operating speed of 8 mph in 3.5 seconds—to 13 mph in 5.5 seconds. Exclusive Yale Torque Transmission (fully automatic) permits quicker, smoother starting, eliminates shifting, provides more power under load conditions—speeds cycle operations. Gasoline or LP-Gas.

EXTRA SAFETY. Yale's exclusive Safety-Curve Arms assure extra-safe elbow room—extra visibility when bucket is raised.

EXTRA MANEUVERABILITY. This is the first tractor shovel designed especially for *industrial* use. It's *compact*—only 117" overall length—can maneuver in any aisle wide enough for a wheelbarrow.

EXTRA LOADING AND DUMPING FEATURES. Yale's exclusive 45° ground-level tipback insures the ultimate in loading action—and a grade-level carrying position to minimize spillage. Exclusive 6' dumping clearance is the highest on any model of similar wheelbase. Bucket is automatically self-locating—lowers from full dump-position to ground-level. Bucket automatically returns to digging position.

For a demonstration in your plant or for actual case histories, write to The Yale & Towne Manufacturing Co., Philadelphia, Pa., Dept. A-4410.

COMPARE!

For only 3¢ more per hour* the Yale Industrial Tractor Shovel offers these exclusive features

- Exclusive Yale Torque Transmission (fully automatic)
- Exclusive 45° ground-level bucket tipback
- Exclusive Safety-Curve Arms
- Exclusive accelerating speed of 8 mph in 3.5 sec.
- Exclusive sealed brakes
- Exclusive forward and rear operating lights
- Exclusive 6' dumping clearance

*Based on comparative initial costs depreciated over 10,000 working hours.

YALE* *REG. U.S. PAT. OFF.

INDUSTRIAL LIFT TRUCKS & TRACTOR SHOVELS • HOISTS

YALE & TOWNE

GASOLINE, ELECTRIC, DIESEL & LP-GAS INDUSTRIAL LIFT TRUCKS • WORKSAVERS
WAREHOUSERS • HAND TRUCKS • INDUSTRIAL TRACTOR SHOVELS • HAND AND ELECTRIC HOISTS

YALE MATERIALS HANDLING DIVISION. THE YALE & TOWNE MANUFACTURING CO. MANUFACTURING PLANTS: PHILADELPHIA, PA.; SAN LEANDRO, CALIF.; FORREST CITY, ARK.

hydrofluoric acid—to 500° F, in any concentration can't corrode Fluoroflex®-T pipe

liner of Teflon® in thermal equilibrium with housing

Lining is completely inert to all corrosives. It's made of Fluoroflex-T, a high density, *non-porous* compound* of virgin Teflon.

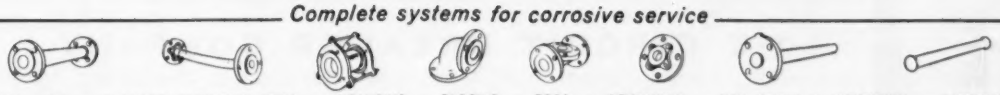
Liner and housing are in thermal equilibrium through an exclusive process developed by Resistoflex. It compensates for thermal expansion differential between the Teflon and the pipe housing, eliminating fatigue collapse, and cracking at the flange.

Reboilers constructed from Type S pipe are now in use handling boiling hydrofluoric acid with complete safety and *no* maintenance problems. Fluoroflex-T Type S piping systems can end maintenance problems for you, too. Bulletin TS-1A gives details. Write Dept. 143 RESISTOFLEX Corporation, Roseland, N. J. *Pat. No. 2,752,637

® Fluoroflex is a Resistoflex trademark, reg., U.S. pat. off.
® Teflon is DuPont's trademark for TFE fluorocarbon resins.

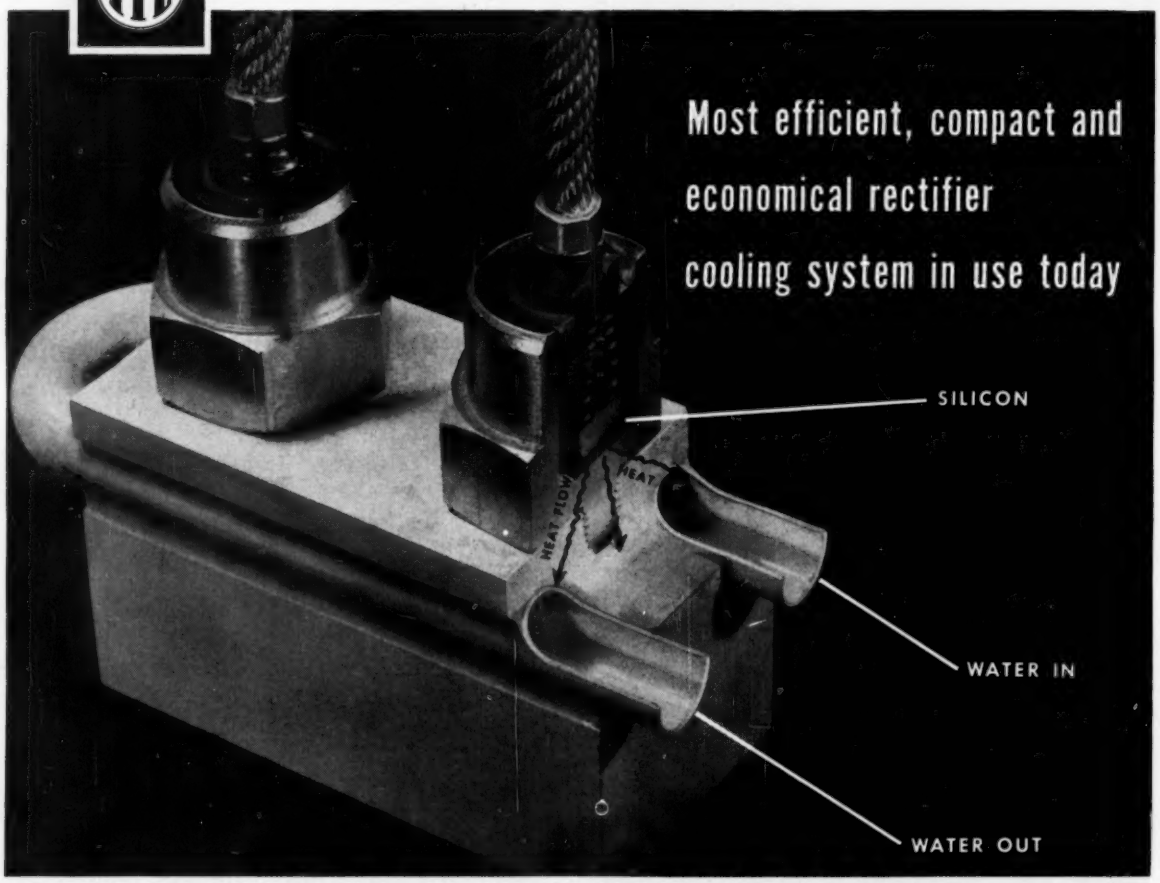
RESISTOFLEX

Complete systems for corrosive service



LINED STEEL PIPE • FLANGED FLEXIBLE HOSE • BELLOWS • ELBOWS • TEES • REDUCERS • DIP PIPES & SPARGERS • LAMINATED PIPE

UNITRON SEMI-CONDUCTOR RECTIFIER



Section of bus bar...showing how cooling water flows close to cells for efficient cooling. Bus bar can be as long as necessary to hold the number of cells needed for the required current. Cells can be changed fast and easy without need to drain cooling system or shut down rectifier.

Just in the cooling system alone, the I-T-E UNITRON Semi-Conductor Rectifier saves you money. First, it costs so little to operate. Second, it takes little space. Third, it prolongs average cell life.

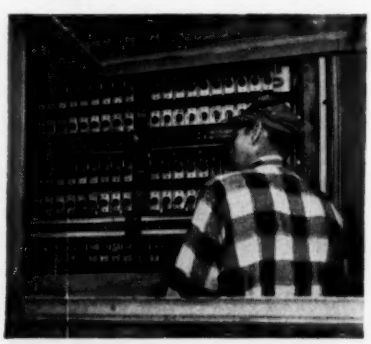
Uses ordinary tap water. No coolant is more efficient than water . . . none more economical than tap water. The I-T-E UNITRON takes ordinary tap water and continuously purifies it . . . deionizes it . . . to protect the system from corrosion and prevent electrical leakage. The resultant water is virtually a non-conductor of electricity.

The I-T-E UNITRON water cooling system eliminates the need for power-eating blowers and space-eating ducts. It saves the cost of special coolants and the danger of skin irritation to personnel.

Cooling water flows through the solid copper bus bar, close to the rectifying cells. Each cell is cooled to the same temperature. And since there are no hot cells, there are fewer cell failures.

This unique water cooling system is only one of the reasons the I-T-E UNITRON was chosen for the first 25 to 60 cycle reconversion by a large chemical plant in the Niagara area.

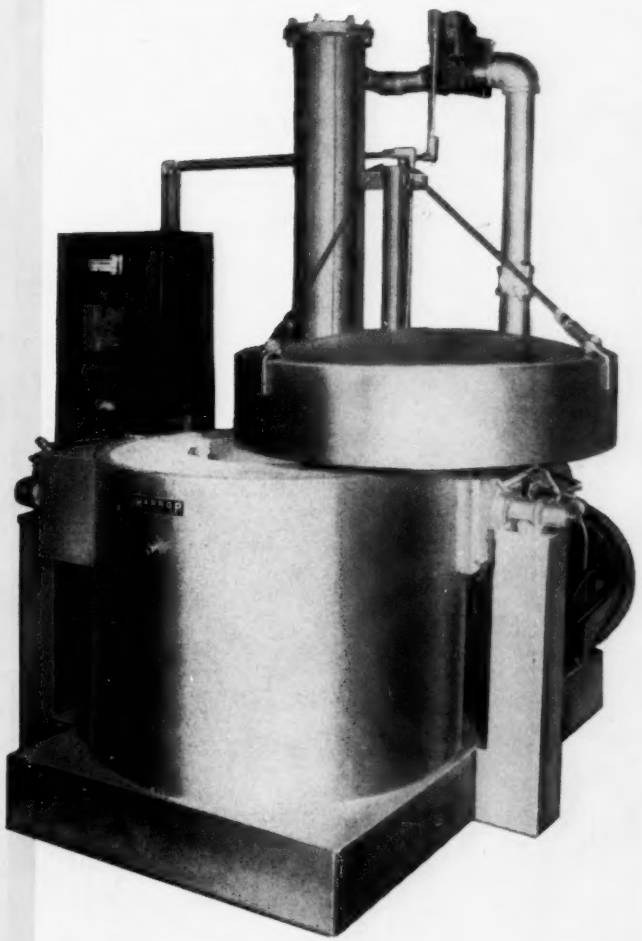
The I-T-E UNITRON can be built in any desired d-c voltage and current rating. For complete information, contact your local I-T-E representative. Or write I-T-E Circuit Breaker Company, Transformer & Rectifier Division, 19th & Hamilton Sts., Philadelphia 30, Pa.



I-T-E CIRCUIT BREAKER COMPANY

New Protection For YOUR Equipment— At Temperatures Up To 3300°F

ALUNDUM castables offer unusual advantages to all industries using high temperature installations*



Will fire continuously up to 3300°F. This Harrop gas-fired furnace, recently developed by the Electric Furnace Division of the Harrop Ceramic Service Company, Columbus, Ohio, is particularly applicable to the firing of ceramic oxide bodies. Norton ALUNDUM 33-I Insulating Castable selected for the inner lining of the furnace and its roof, provided completely satisfactory protection under repeated tests at highest operating temperatures.

The new Norton ALUNDUM Castables are made in two types: 33-I Insulating and 33-HD Heavy Duty. At temperatures up to 3300°F both types have been extremely successful in protecting high temperature processing — in many industries and many different installations.

ALUNDUM 33-I Insulating Castable is made up primarily of pure aluminum oxide bubbles, tiny and countless. Forming a network of air spaces, it assures excellent insulation, even at highest commercial temperatures.

ALUNDUM 33-HD Heavy Duty Castable is chiefly composed of dense grains of pure aluminum oxide. It is recommended for forming dense monolithic surfaces in many types of furnaces where high temperature conditions are particularly severe.

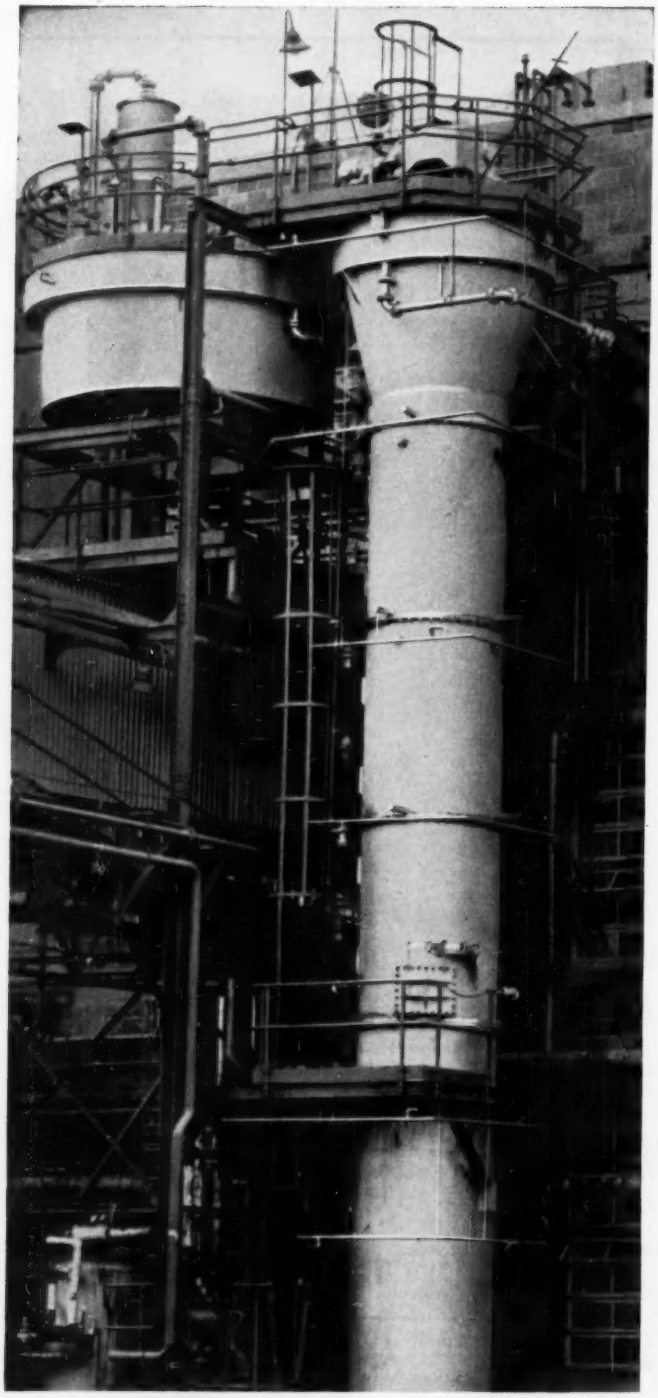
Both 33-I and 33-HD Castables are very easy to store, mix and use. With them you can cast simple or complex shapes quickly and economically, replace more expensive pre-fired shapes, and cut maintenance and replacement costs to very lowest. Ask your Norton Representative for details, and for the folder *Two Norton Castables.* Or write to NORTON COMPANY, Refractories Division, 510 New Bond Street, Worcester 6, Massachusetts.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

NORTON
REFRACTORIES
Engineered... Rx ...Prescribed

Making better products . . . to make your products better

NORTON PRODUCTS Abrasives • Grinding Wheels • Grinding Machines • Refractories • Electrochemicals — **BEHR-MANNING DIVISION** Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes



Special Manhattan Rubber Lining to resist acidified solvent and abrasive cake is installed in this extraction tower for removal of anti-biotic from mycelia cake.

PERMANENT CORROSION, CONTAMINATION PROTECTION WITH MANHATTAN RUBBER LININGS

Manhattan Acid-Proof Rubber Linings are made from thick, multiple calendered sheets of natural or synthetic rubber for utmost protection and durability. These linings expand and contract with the metal under temperature changes . . . won't harden or crack. Resistance to most acids and alkalis is as foolproof as 65 years experience and advanced technology can provide.

Every Manhattan Rubber Lining is bonded to metal so securely that they can't be separated . . . Every Manhattan Lined tank is tested under high voltage to assure flawless protection before being shipped to your plant. If the equipment *can't* be shipped to Manhattan, skilled crews will line the equipment in the field.

For permanent, positive protection for your processes *and* equipment, contact the R/M representative at the Manhattan Rubber Lining plant nearest you.

RUBBER LINING PLANTS AT
PASSAIC, N. J. and NORTH CHARLESTON, S. C.

RM 804

BELTS • HOSE • ROLL COVERINGS • TANK LININGS • INDUSTRIAL RUBBER SPECIALTIES

MANHATTAN RUBBER DIVISION — PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.

Other R/M products: Abrasive and Diamond Wheels • Brake Blocks and Linings • Clutch Facings • Asbestos Textiles • Mechanical Packings • Engineered Plastics • Sintered Metal Products • Industrial Adhesives • Laundry Pads and Covers • Bowling Balls

RM

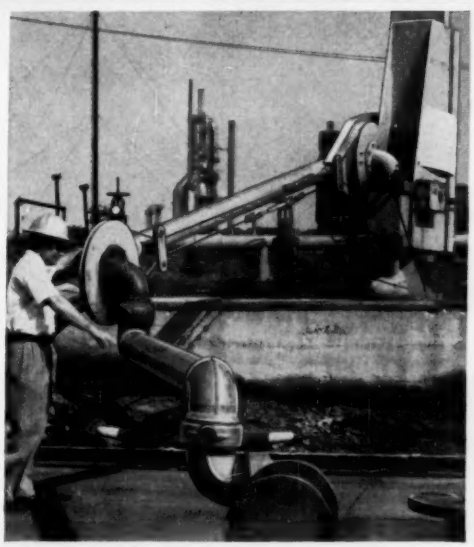
CHIKSAN

PREVENTS LINE HANDLING INJURIES
SPEEDS BARGE LOADING
ELIMINATES HOSE BURSTS
SLASHES REPLACEMENT COSTS

The Chiksan Barge Loading Arm ends hazardous manhandling of loading hoses, eliminates dangerous dock clutter. Mechanical operation makes hookup fast and simple.

Gear reduction enables one man to adjust the flange position anywhere in a 105° vertical range. Outboard arm is manually swung into position at any point in a 130° horizontal arc. The eight inch model rotates 360° to permit servicing barges on both sides of a narrow dock. Once hookup is made, the arm can be left unattended while free wheeling allows the unit to ride free during loading and unloading. When not in use, the arm is raised up and out of dockside traffic.

6″ x 25′ and 8″ x 28′ sizes available. Handle petroleum products, both black and bright, and mild caustics in any temperature ranging between −60° F. to +225° F. Service all river and lake barges and lake tankers including those in 25,000 barrel class.



The Chiksan Barge Loading Arm is designed to reach approximately 20 feet from dock riser to barge flange. Total length of Arm is 25 feet.

fmc CHIKSAN
A SUBSIDIARY OF
FOOD MACHINERY AND CHEMICAL CORPORATION

CHIKSAN COMPANY — BREA, CALIFORNIA
CHICAGO 5, ILLINOIS • NEWARK 2, NEW JERSEY
Well Equipment Mfg. Corp. (Division), Houston 1, Texas
Subsidiaries: Chiksan Export Company
Chiksan of Canada, Ltd.

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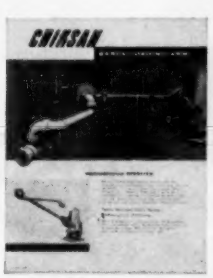
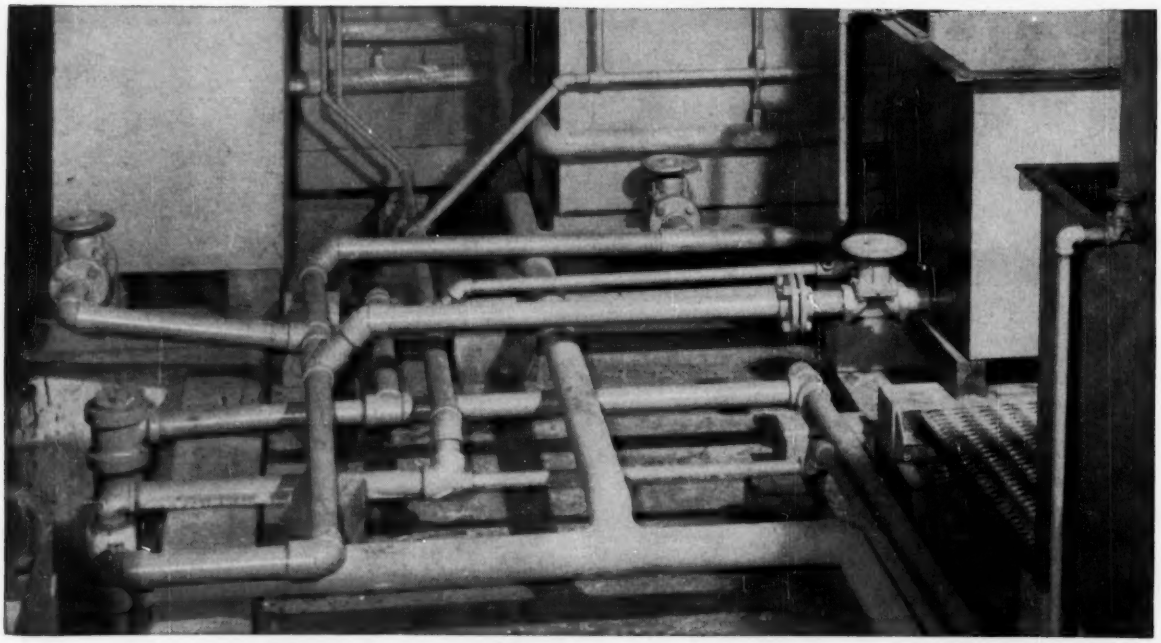


CHIKSAN COMPANY
330 No. Pomona Ave., Brea, Calif.

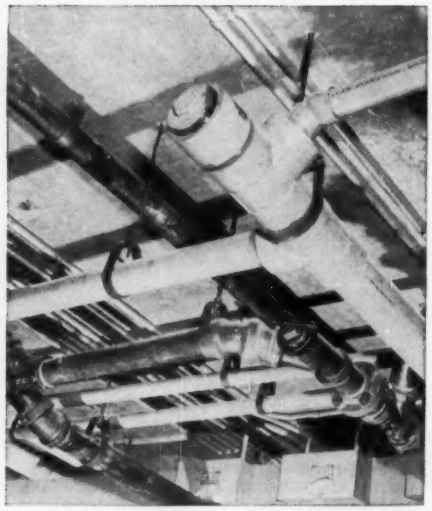
Please send me your Barge Loading Arm Bulletin #456.

Name_____
Title_____
Company_____
Address_____
City_____ Zone____ State_____



Muriatic acid lines of USS National PVC Pipe

used at National Lock Fastener Plant



The National Lock Co. Fastener Division, Rockford, Illinois, is using 3,000 feet of USS* NATIONAL Polyvinyl Chloride Pipe in sizes from 1" to 4" O. D. to convey muriatic acid, deionized water and acid wastes for their plating process. Their choice was dictated by USS NATIONAL* PVC Pipe's immunity to acids and corrosion, and its excellent economy.

Two types of USS NATIONAL PVC Pipe are available:

Normal Impact—for installations requiring the highest chemical resistance attainable, together with high strength and excellent creep resistance.

High Impact—for installations requiring excellent chemical resistance and a high degree of toughness, even at low temperatures.

USS National PVC Pipe comes in sizes from ½ inch to 14 inches in diameter, and in Schedules A, 40, 80 and 120.

National Polyvinyl Chloride Pipe has a variety of uses in the chemical industry because it is resistant to many chemicals, including acids, alkalies, salt solutions and alcohol.

If you'd like more information, write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa. Ask for Bulletin No. 24.

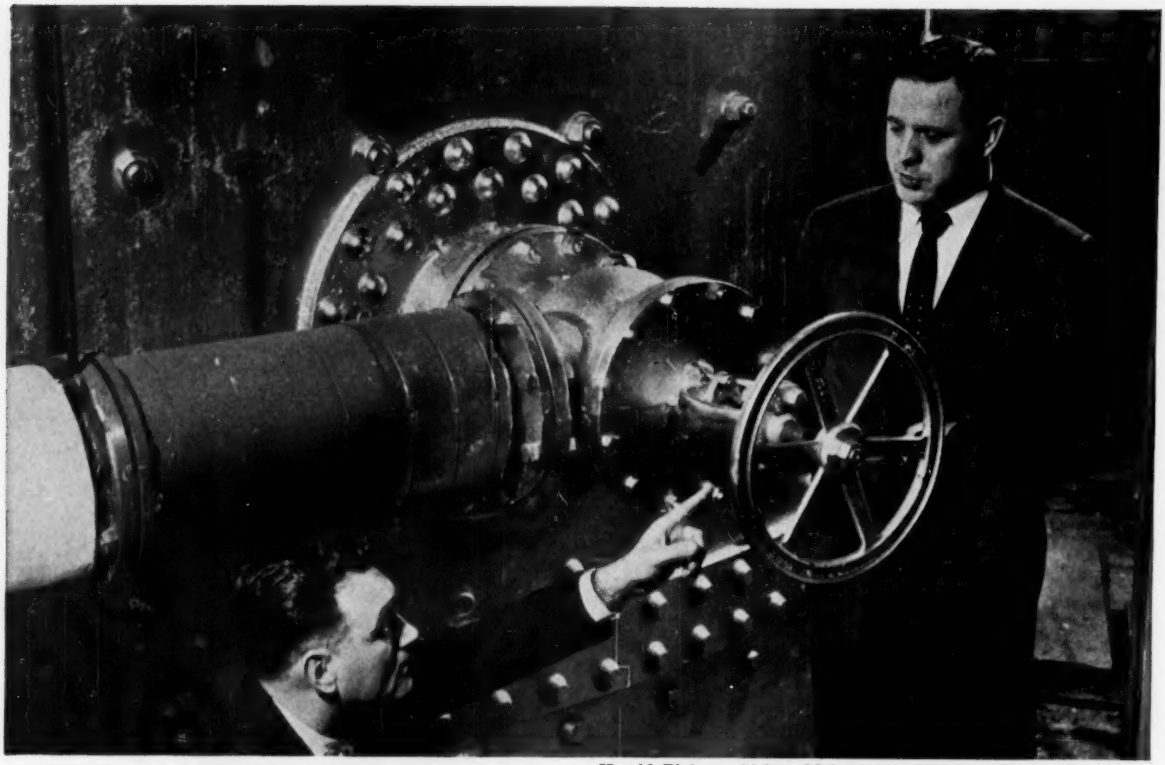
"The world's largest and most experienced manufacturer of tubular products—NATIONAL TUBE"

This seal of the National Sanitation Foundation means Tested . . Approved . . Sanitary!

National Tube Division of United States Steel

*TRADEMARK

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • United States Steel Export Company, New York



Harold Blakney (right), Maintenance Manager, Brown Company, Berlin, N. H. Left, Frank Hiltz, Vice President Brown Wales Co., Cooper Alloy distributors, Auburn, Me. Center, Cooper Alloy 8" angle circulating valve on digest tank.

BLAKNEY of BROWN COMPANY

tells why Cooper Alloy Valves suit him

Q. *Mr. Blakney, why does Brown Co., a leading manufacturer of pulp, paper, and other forest products, use stainless valves and fittings in its mills?*

A. Because stainless steel is one of the few materials that can take the tough corrosion punishment of pulp mill digester fluids.

Q. *Why Cooper Alloy valves?*

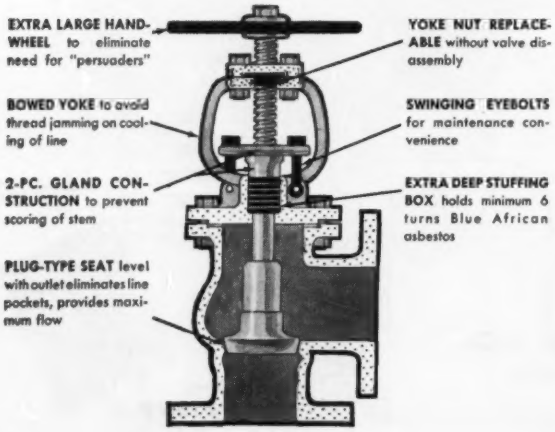
A. For long life and low maintenance. Over the years Cooper Alloy valves have proven themselves to be extremely well designed for the tough service we give them.

Q. *How, specifically?*

A. Well, these 8" angle valves, for example, have that extra-deep stuffing box to give a tighter stem seal. The seat, level with the outlet, eliminates line pockets and provides maximum flow. These plus extra large handwheel all give me less maintenance problems.

Q. *Anything else you like about Cooper Alloy valves?*

A. Yes, I like the engineering service available from Cooper Alloy we have had occasion to use, and the fine fast delivery and service we obtain from Brown Wales' nearby warehouse.



A VALVE DESIGNED FOR STAINLESS! The Cooper Alloy valve is not an adaptation of earlier brass and iron patterns. Cooper Alloy, with over 35 years of experience in handling stainless steel, created a valve *designed to be cast in stainless!* Check the Special Design Features shown at left.

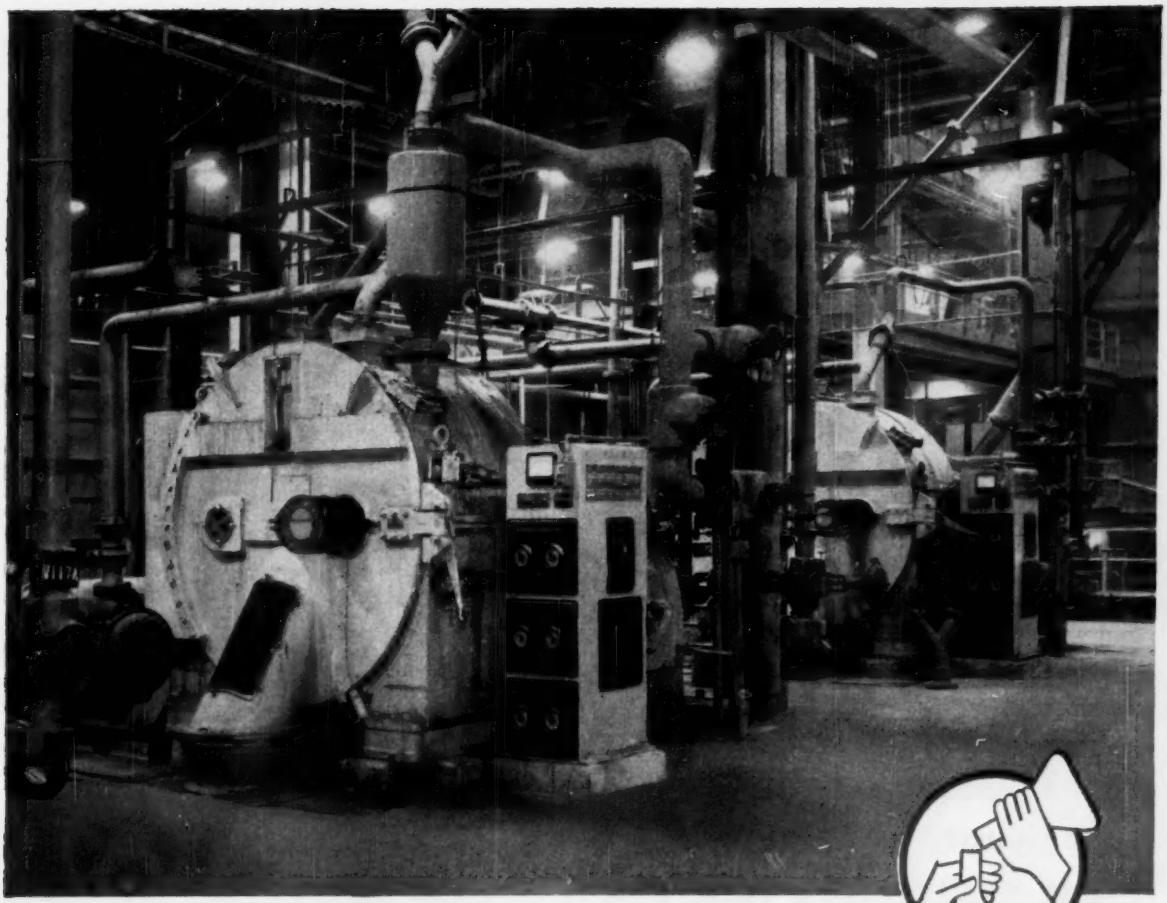
As the little CA man below is saying: "*You can tell a Cooper Alloy Valve as far as you can see it!*" Write today for *your* copy of our folder "Valves and Fittings in the Pulp and Paper Industry." The Cooper Alloy distributor near you will be glad to show you the complete line of Cooper Alloy valves *and fittings*, and their advantages. He can serve you promptly from local stocks.

COOPER ALLOY

Corporation • Hillside, New Jersey

FOUNDRY PRODUCTS DIVISION

THIRTY-FIVE YEARS OF STAINLESS STEEL PIONEERING



B-P CENTRIFUGALS used by ELECTRO METALLURGICAL COMPANY in Titanium Production

Although a metal, titanium is produced by a chemical process. Metal in the form of ore is converted to titanium tetrachloride, which is purified and then reduced to metallic sponge by sodium. In order to separate the brine from the titanium sponge, Electro Metallurgical Company, Division of Union Carbide Corporation, New York, utilizes Baker Perkins 66" diameter type HS Universal Centrifugals. It's a tough application, but the B-P Type HS has proven itself efficient and dependable. These same machines are adaptable to a wide range of filterable fine solid-liquid slurries. Baker Perkins also manufactures type S Continuous Centrifugals which are used extensively for the separation of filterable coarse solid-liquid slurries.

Since centrifugation is such an important process in the chemical industry, and, since there are so many types of slurries that must be separated, Baker Perkins engineers give special design consideration to each specific problem. No matter what factors are involved in each application, our engineers can make recommendations on the proper centrifugal machinery.

Send for your copy of Catalog CE-58 for complete information on size, type and capacities of Baker Perkins "Tor Mear" Centrifugals.

BAKER PERKINS INC. CHEMICAL MACHINERY DIVISION SAGINAW, MICHIGAN

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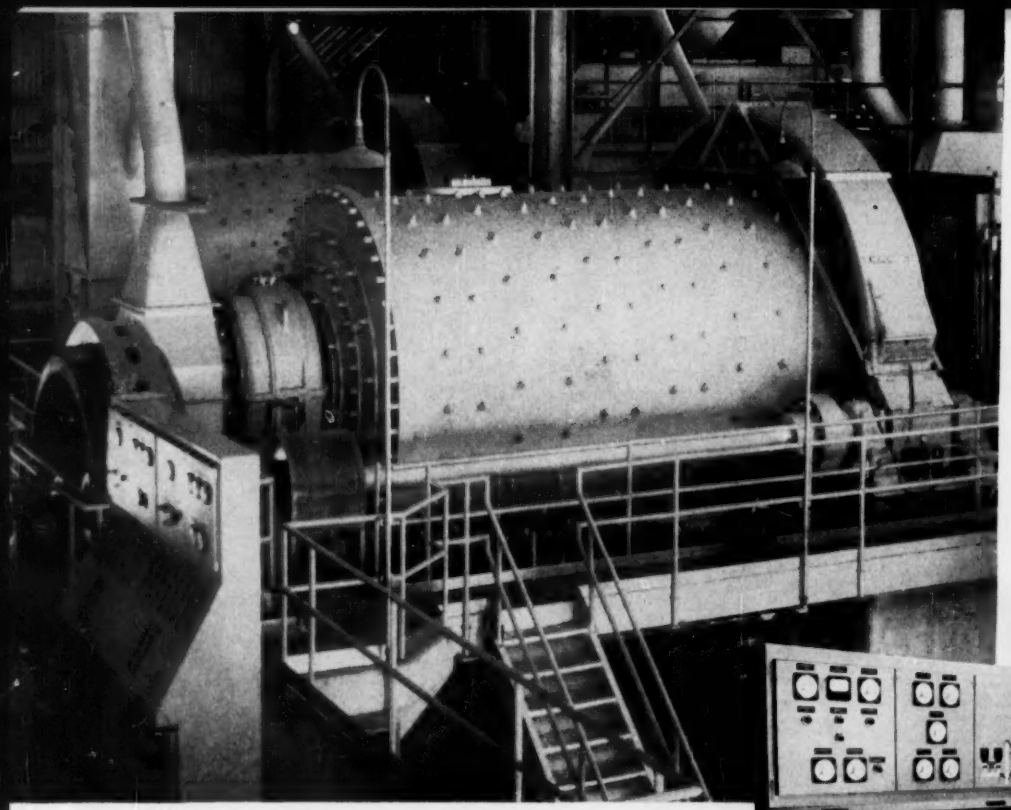
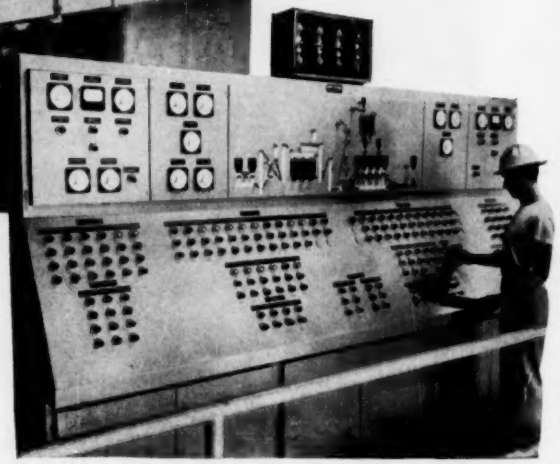


Left: Two of five 11′ x 17′ Nordberg Grinding Mills installed for dry process service at a new cement plant.

Below: Close-up view showing modern, functional Nordberg grinding mill control console, with interlocking relays for sequence starting of all equipment. Note flow diagram with indicator lights at center of top panel.



3 reasons why it pays to specify NORDBERG GRINDING MILLS

1 Advanced Engineering Nordberg mill design reflects significant technological improvements that may measurably affect your installation and operating costs. Sealed trunnion bearings; positive bearing lubrication; optimum life of wearing parts are among the features that will benefit you.

2 Quality Manufacture Nordberg Mills are (1) precision built to rigid specifications in shops renowned for (2) skilled manufacturing personnel, and (3) modern machine tools and equipment to assure quality workmanship. Good reason why the name NORDBERG has always signified the *ultimate* in mining, quarrying and process machinery.

3 Dependable Operation A team of experienced application engineers with a sound understanding of your milling operations qualifies Nordberg to serve you. More important, it assures you of the right machinery for the job . . . machinery that must be dependable and will continually produce to your specifications.

Nordberg Grinding Mills are built to meet specified conditions for wet or dry grinding—in the manufacture of cement; the fine reduction of metallic and non-metallic minerals; and in numerous other processes where friable material must be comminuted to fine sizes at low cost per ton. They are available with grate, overflow or peripheral discharge . . . and are built in sizes from 6 feet to 13 feet in diameter and up to 50 feet in length.

Write for a copy of Bulletin 232, which describes the complete line of Nordberg Grinding Mills.

NORDBERG MFG. CO., Milwaukee 1, Wisconsin

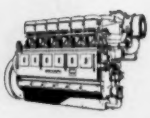
NORDBERG

ATLANTA • CLEVELAND • DALLAS • DULUTH • HOUSTON • KANSAS CITY
MINNEAPOLIS • NEW ORLEANS • NEW YORK • ST. LOUIS • SAN FRANCISCO
TAMPA • WASHINGTON • TORONTO • VANCOUVER • GENEVA
JOHANNESBURG • LONDON • MEXICO, D.F.

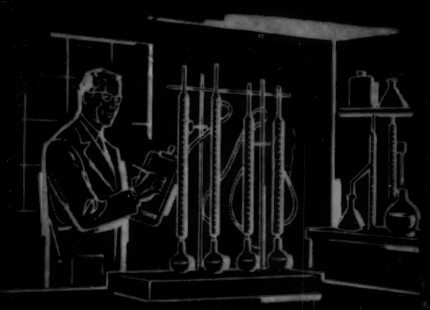
SYMONS® CONE CRUSHERS

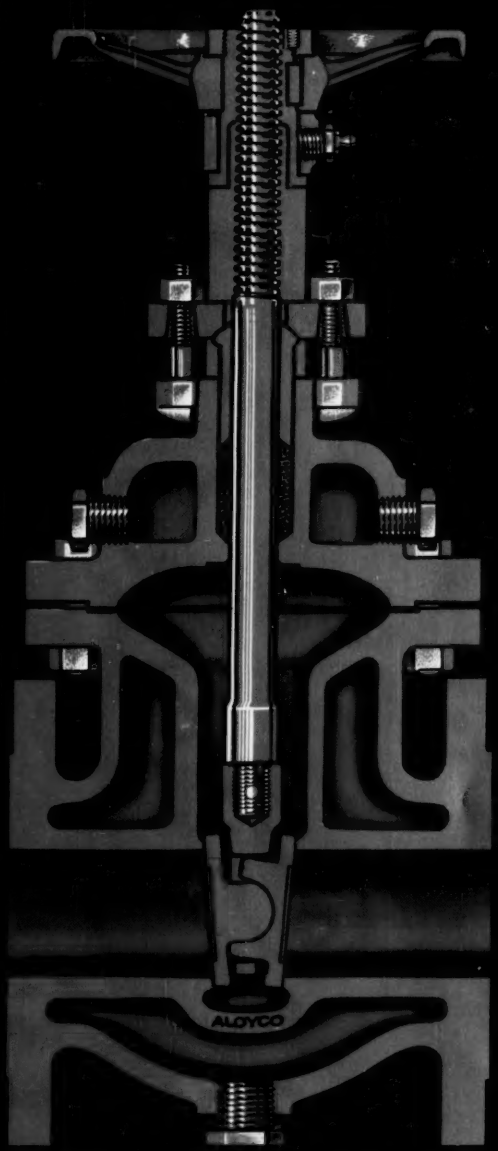
SYMONS VIBRATING GRIZZLIES and SCREENS

ROTARY KILNS and COOLERS



NORDBERG ENGINES to over 11,000 H.P.





Thirty years' research devoted exclusively to...

STAINLESS STEEL VALVES

Aloyco's specialized research . . . in the field and in the lab . . . brings you a wealth of metallurgical information for successfully solving your corrosives-handling problems.

Coupled with continuing research in design, foundry and machining techniques, this Aloyco specialization results in new and better corrosion resistant valves for many specific applications. One example above: Aloyco completely jacketed valves (the first ever to be integrally cast in high alloys) are designed for viscous liquids and other fluids difficult to move at room temperatures.

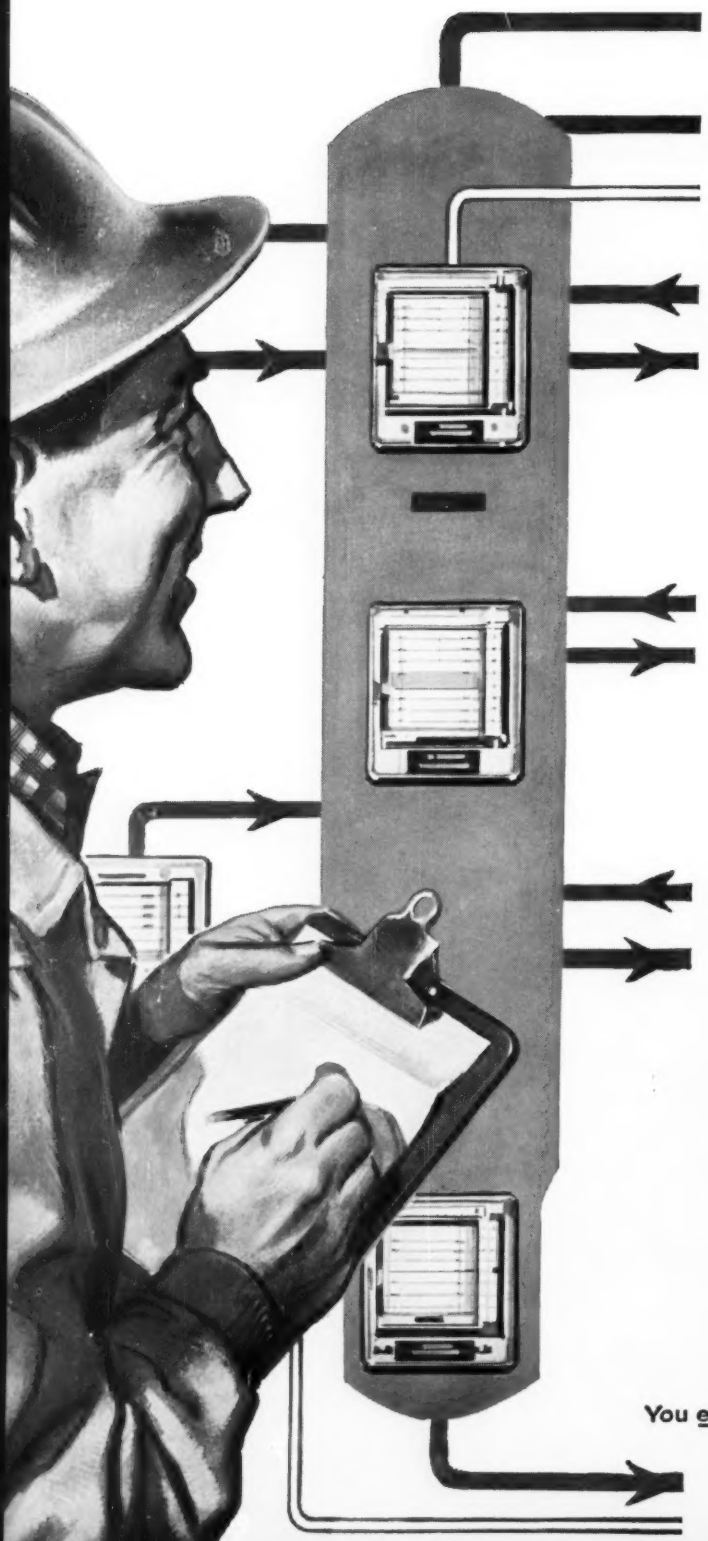
Isn't your surest source of supply the one company with research, manufacturing and sales all devoted to Stainless Steel Valves exclusively?

ALLOY STEEL PRODUCTS COMPANY

Linden, New Jersey

Nothing gets by

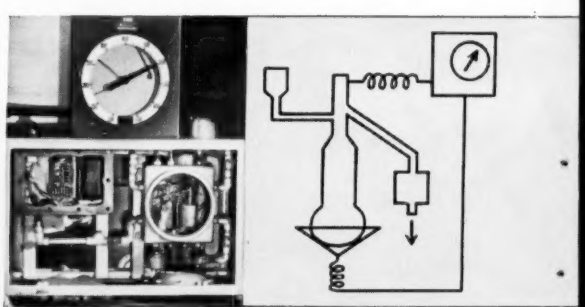
Automatic end-point testing device developed by Standard Oil research men makes certain of the uniform quality of gasoline and diesel fuel delivered to you.



Scientists at Standard Oil never stop in their drive to improve and then improve again the uniform quality of the petroleum products that bear the Standard Oil trade-mark. These engineering research scientists have now created wholly new instruments for performing near continuous physical analysis *automatically*.

One such instrument automatically performs the physical analysis that determines end-point. Using it, refineries maintain a continuous inspection of the temperature at which gasoline and diesel fuels are completely distilled. To you, this means that Standard is able to maintain a constant control over the uniformity and high quality of (1) the fuels you burn for heat or use to power your diesel engines and (2) the gasoline for your truck fleets. It also means that power- and heat-producing petroleum products, with their constantly controlled end-point, burn uniformly, give you uniform high performance.

This is part of the research pay-out, the "something more" research builds into the products you buy from Standard. This is your return from Standard's investment in research. And now there are 48 district offices in the 15 Midwest and Rocky Mountain states to serve you. Call the one nearest you. **Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.**



Automatic end-point tester works this way. A small sample is placed in an electrically heated flask. The temperature is measured and recorded during a heating cycle when distillation is accomplished. Distillate is condensed and drained, the flask temperature is lowered by introduction of the next sample, and the apparatus is ready for another test.

You expect more from STANDARD and get it!

Ro-Flo COMPRESSORS

Operation is simple—centrifugal force holds blades against sidewall to form air chamber.

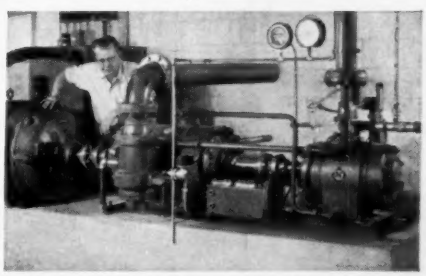
Two-stage rotary compressor supplying plant air for a midwestern manufacturing company.

No shake...no shimmy...no shock!

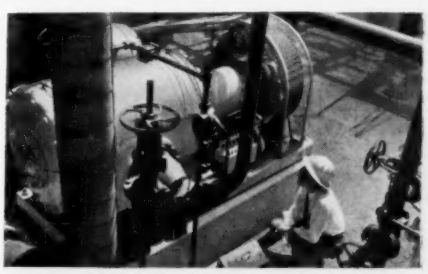
Rotary operation produces a remarkably stabilizing effect. You don't get the shimmy and shock inherent in reciprocating compressors.

Users in many industries have discovered that *Ro-Flo* compressors eliminate the cost of heavy foundations. A simple slab is enough. Smaller units are bolted directly to the floor. Automatic wear compensation at the rotor blades keeps compressor efficiency at high level even after years of use. There are only two wearing parts.

Ratings—Choose from twelve sizes of two-stage *Ro-Flo* compressors, ranging from 250 to 1800 cfm at pressures from 60 to 125 pounds gauge. Single-stage *Ro-Flo* units handle pressures up to 50 pounds gauge, and handle volumes from 40 to 3000 cfm.



Two-stage rotary compressor used for plant air service in a midwestern plant.



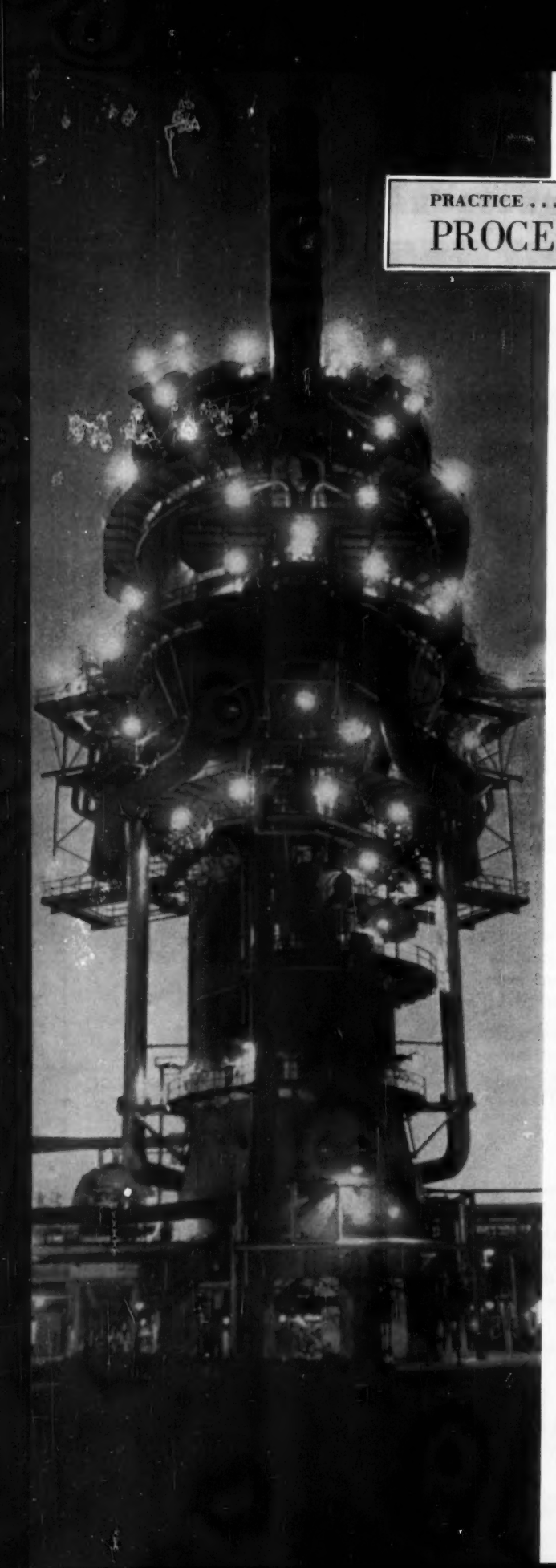
Ro-Flo hydrogen compressor in a southwestern plant, used here in conjunction with acrylic monomer process.

For complete information on Allis-Chalmers rotary compressors, ask for two-stage Bulletin 16B8244 or single-stage Bulletin 16B8126. Call your nearby A-C office or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wis.

Ro-Flo is an Allis-Chalmers trademark.

ALLIS-CHALMERS

A-5713



PRACTICE . . .

PROCESS FLOWSHEET

C. H. CHILTON

In: Gas-solids contacting
Piping design
Fluidizing techniques
Materials of construction . . .

Cat Cracker Sets Challenges

Crowning the trend toward bigger, higher-capacity refinery equipment, Tidewater Oil's giant Orthoflow fluid catalytic cracking unit* at its Delaware refinery, south of Wilmington, stands as the largest such unit in the world (design capacity: 102,000 bbl./day) and as an impressive (height: 250 ft.) monument to king-size engineering effort (maximum operating catalyst inventory: 1,300-1,400 tons).

Tidewater's cracker has now completed nearly two years of successful operation (15 months since the last turnaround), proving that, in many technical respects, bigness pays off.

Operating in conjunction with a fractionating tower, cracker's prime purpose is to convert gas oils to high-octane gasoline (29,000 bbl./day). Other large-scale product streams from the fractionator are 18,000 bbl./day of light gas oil and 184,000 lb./hr. of butanes and lighter.

▶ **Size Is the Spur**—A description of the unit's immense size points up the most formidable engineering problems.

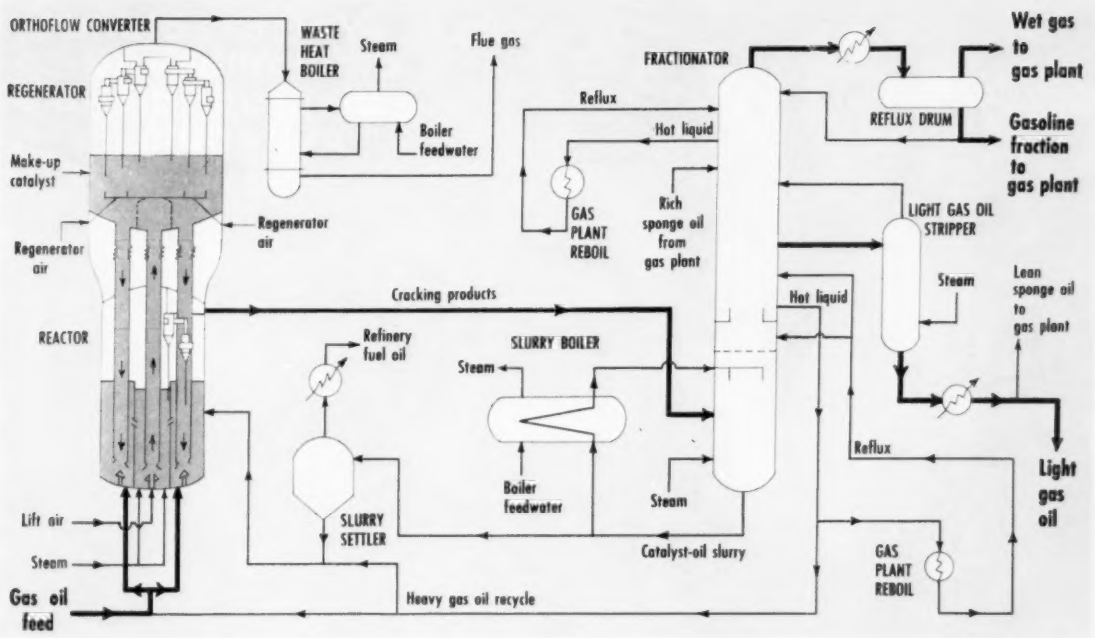
Cracker consists of a single 200-ft.-high converter vessel which houses reactor and catalyst regenerator, contains facilities for cracking and for catalyst stripping, regeneration and circulation. The 60-ft.-dia. regenerator is mounted on top of the reactor vessel which contains the catalyst stripper in its center section. Maximum total weight is 9,500 tons.

Regenerated alumina-silica gel catalyst flows from regenerator down through straight, 28-in.-dia. refractory-lined standpipes into the reactor bed.

Spent catalyst flows into the stripping zone through slots in the cylindrical plate that separates this section from the reaction zone, and then is air-conveyed

*Designed by M. W. Kellogg Co., built by C. F. Braun Co.

Unfold Flowsheet



up through two 42-in.-dia., refractory-lined risers into the regenerator.

These risers handle catalyst at a whopping rate of 85 tons/min., with linear velocities of 20-30 ft./sec.

► **A Lot of Air**—It's quickly apparent that to circulate and regenerate this amount of catalyst, Tidewater needs air on a mammoth scale. And it has just that.

Regenerator air blower is an Ingersoll-Rand centrifugal blower with a capacity of 137,200 scfm., driven by an 11,250-hp. turbine using steam at 575 psig. and 750 F. Blower takes suction at 14.4 psia. and discharges at 30 psia.

Lift air blower which supplies air to circulate catalyst is an Ingersoll-Rand centrifugal with 29,800-scfm. capacity, takes suction at 14.4 psia. and discharges at 36.1 psia.

► **Making Contact**—Handling such vast amounts of catalyst and air presents a number of problems in pipe design and gas-solids contacting.

Kellogg's design approach involves using two risers and four standpipes—twice the number conventionally used in Orthoflow units—to help catalyst distribution. Multiple pipes, together with a large number of oil inlets to the reactor (28, including those for recycle), assure good contacting throughout large areas of reactor and regenerator.

Distributing regeneration air is aided by a system of four large half-rings set in the regenerator bed. Perforated tubes, over 2 ft. in dia., are shaped into half-rings about 50 ft. in dia. fed by two air inlets. Having thousands of holes to emit air, distributor does effective job of contacting air with catalyst—more effective, claims Kellogg, than conventional flat grid.

Two- and three-stage cyclones (16 in the reactor, 60 in the regenerator) separate entrained catalyst—about 40 tons/min. in the regenerator alone—and return it to catalyst beds.

► **Construction materials**—Straight risers and standpipes, of course, help reduce pipe wear, but they're refractory-lined, too, to keep erosion to a minimum. Sound thinking led Kellogg to line reactor, regenerator and cyclones with insulating and refractory concrete.

Risers and standpipes are fitted with expansion joints between reactor and regenerator to allow for metal expansion under different operating conditions.

Tidewater avoided costly materials of construction as much as possible. Converter shell is carbon steel, as are reactor cyclones and most of the internals. And, even at the bottom head of the reactor, steel thickness is never over 1½ in.

Lower part of the fractionating column, from above the recycle draw-off pan, is protected from corrosion by an 11-13%-chrome-clad plate.

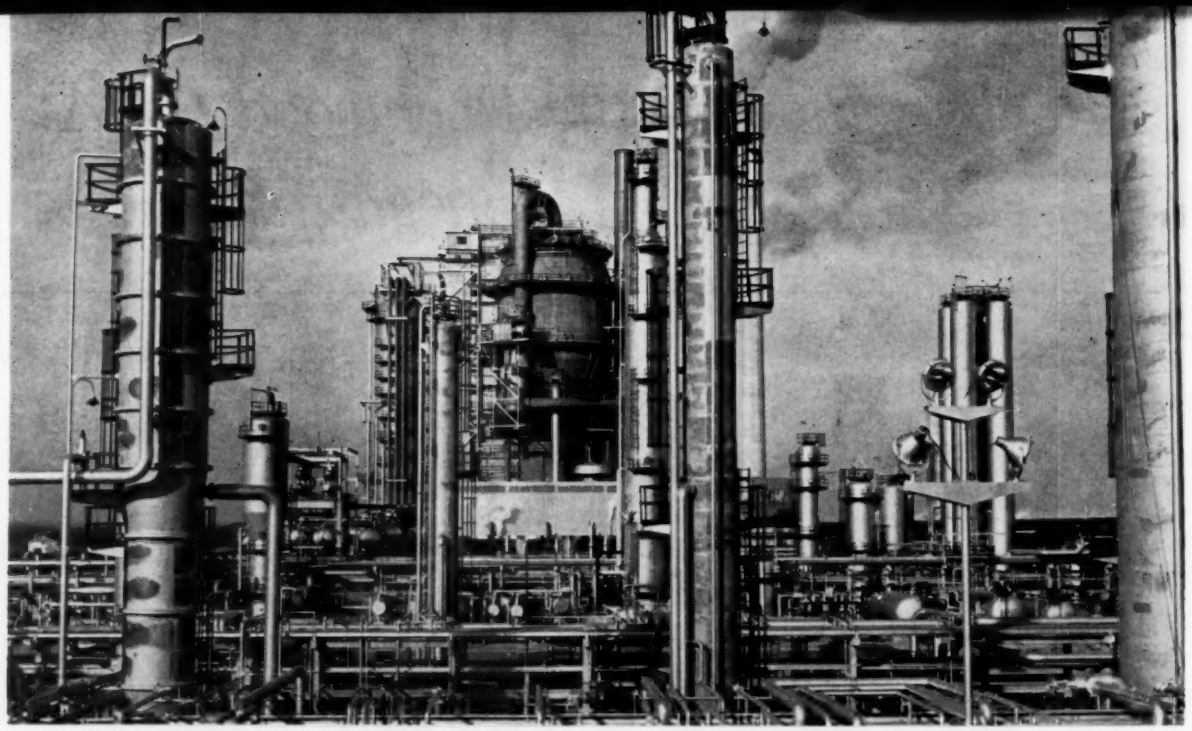
► **Flow Route**—Here's how the fluid cracker works at Tidewater. Gas oil feed, a mixture of virgin and fluid coker gas oils, is fed in the bottom of the reactor, where it passes up through catalyst bed at about 900 F. and is cracked. Cracked vapors pass through reactor cyclones where entrained catalyst is separated and then pass to 25-ft.-dia. bubble-cap fractionating column.

Two waste-heat boilers, hung on either side of the regenerator shell, recover heat from flue gases by generating 175-psi. steam.

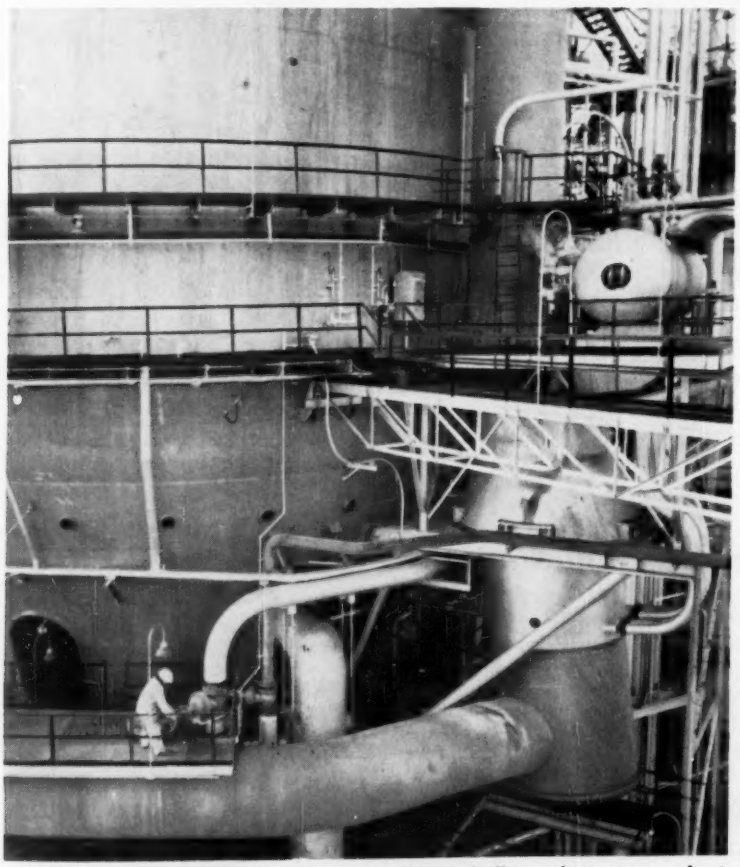
In fractionator, cracking products are split into 430-F.-end-point overhead stream, light gas oil, heavy gas oils and a bottoms stream of catalyst-in-oil slurry, of which part is taken off as fuel oil after catalyst is separated out. Sponge oil cut from the column is pumped to the gas plant to absorb propane and propylenes, then returns to column for stripping.

Two side cuts are taken from fractionator to supply reboil heat for the gas plant to get the needed temperature gradients in the tower for optimum separation.

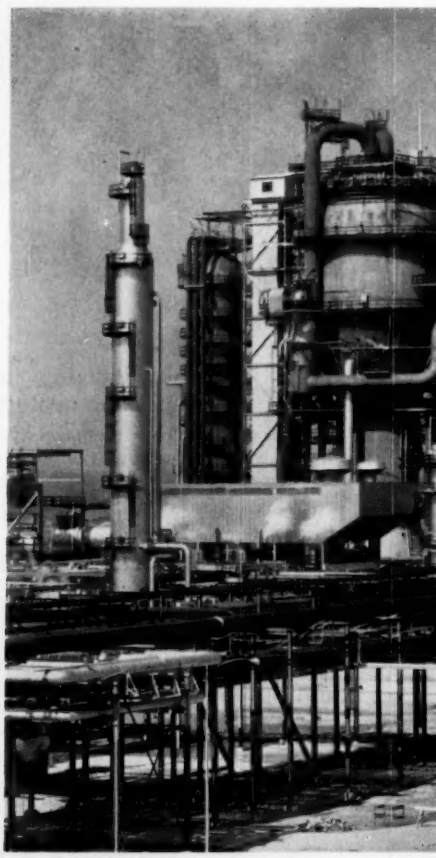
Nearby catalyst storage bins can hold as much as 500 tons of fresh catalyst and 1,800 tons of used catalyst.



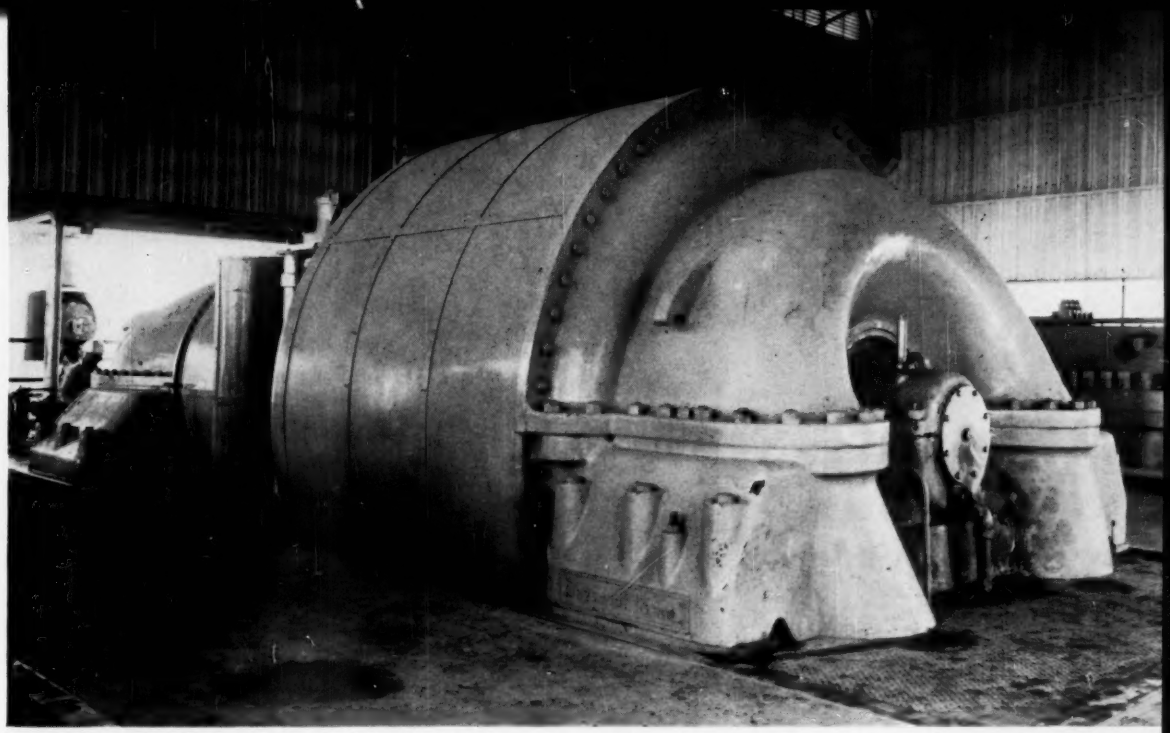
WIDE VIEW OF REFINERY shows how Orthoflow fluid cracking unit dominates maze of piping and towers. In background can be seen cracking-products splitting tower (at left of cracker) and fuel-gas surge tanks (right).



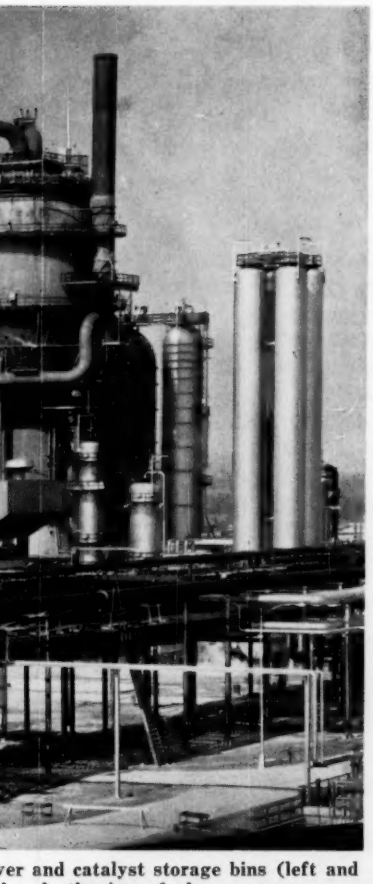
WASTE-HEAT BOILER, at right, one of two similar units, recovers heat from flue gases by generating 175-lb. steam, sends gases to stack.



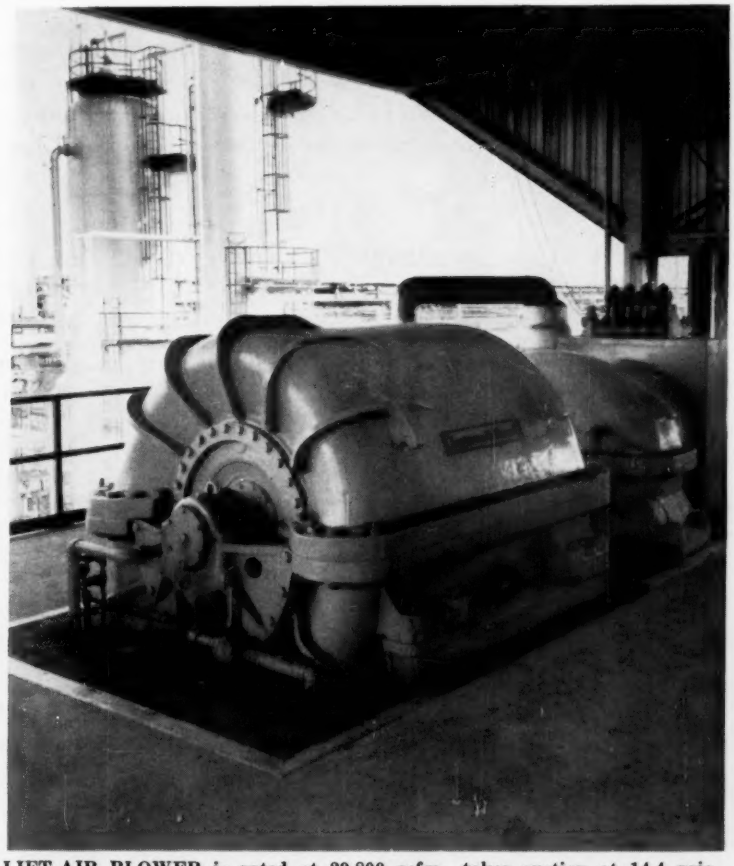
CRACKER is flanked by splitting tower and c
right). Far left and far right: absorber-deeth



REGENERATOR-AIR BLOWER delivers 137,200 scfm., takes suction at 14.4 psia., discharges at 30.0 psia. It supplies combustion air and is driven by an 11,250-hp. turbine using steam at 575 psig. and 750 F.

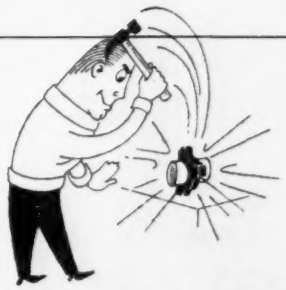


ver and catalyst storage bins (left and
ber-deethanizer, fuel gas surge.



LIFT-AIR BLOWER is rated at 29,800 scfm., takes suction at 14.4 psia., discharges at 36.1 psia. Air circulates almost 90 tons/min. of catalyst.

Rocky tells why the Rockwood 603A makes-up without galling



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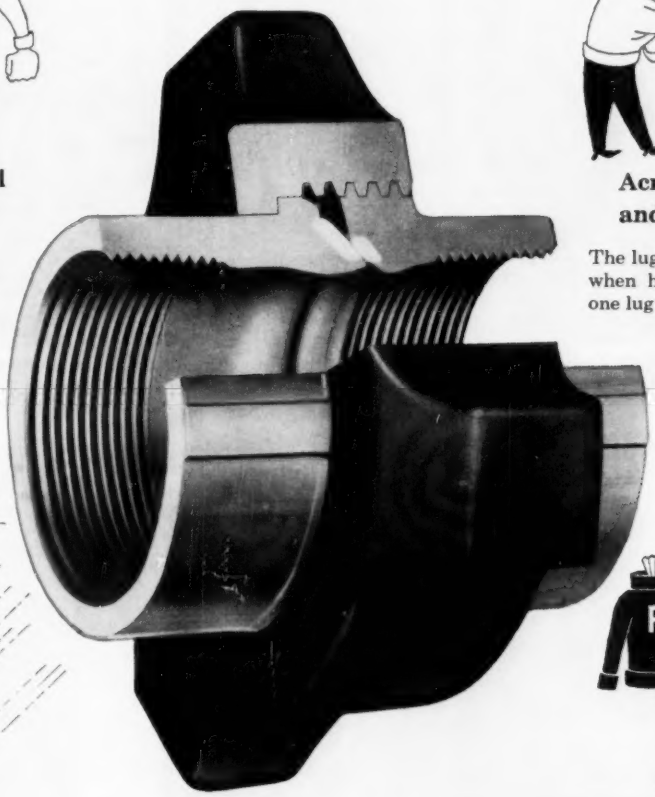

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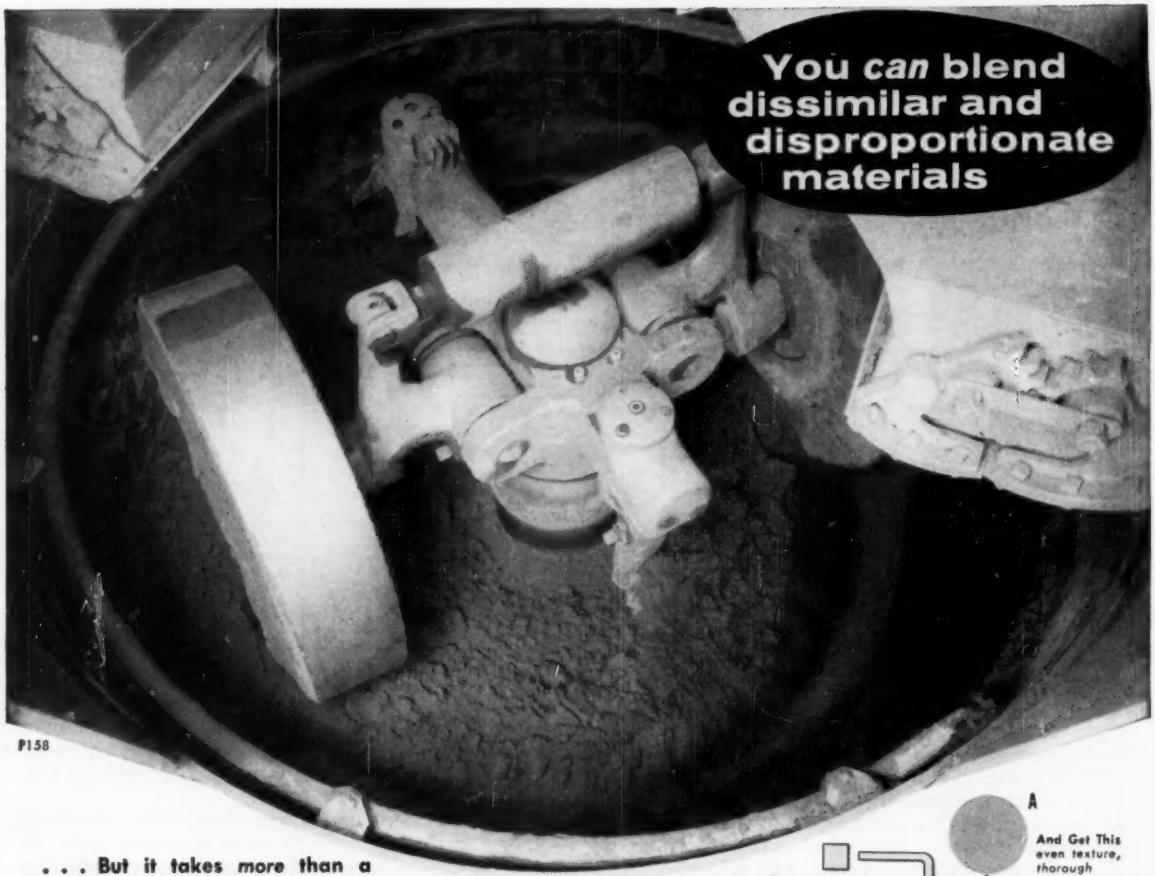

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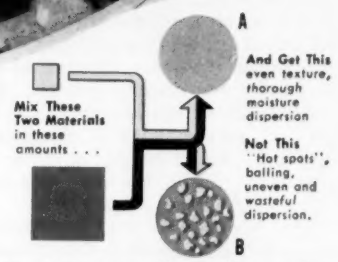

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Chemical Engineering

Practice

OCT. 6, 1958

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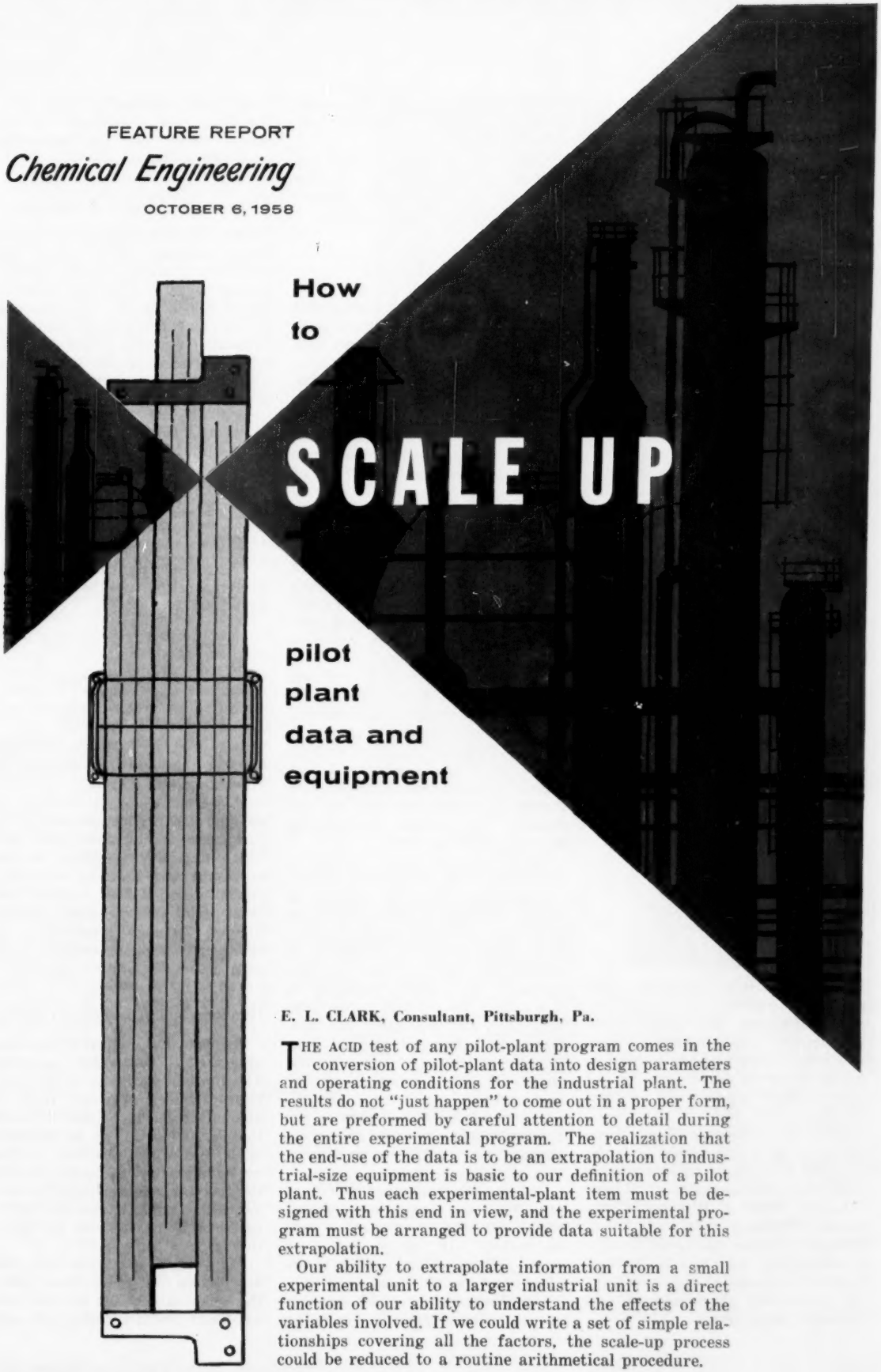

How to SCALE UP pilot plant data and equipment

E. L. CLARK, Consultant, Pittsburgh, Pa.

THE ACID test of any pilot-plant program comes in the conversion of pilot-plant data into design parameters and operating conditions for the industrial plant. The results do not "just happen" to come out in a proper form, but are preformed by careful attention to detail during the entire experimental program. The realization that the end-use of the data is to be an extrapolation to industrial-size equipment is basic to our definition of a pilot plant. Thus each experimental-plant item must be designed with this end in view, and the experimental program must be arranged to provide data suitable for this extrapolation.

Our ability to extrapolate information from a small experimental unit to a larger industrial unit is a direct function of our ability to understand the effects of the variables involved. If we could write a set of simple relationships covering all the factors, the scale-up process could be reduced to a routine arithmetical procedure.

Unfortunately, such a situation is not always apparent or possible. There are many interacting variables which are difficult to reduce to simple relationships.

In addition to the chemical reactions involved, we are often confronted with problems of heat transfer, mass transfer and distribution. The rates of these processes in many cases affect the rates of the chemical reactions, and we encounter situations wherein changes in process variables may affect several competing or opposing processes in a different manner. Furthermore the size and geometry of the equipment can also affect these processes.

A logical approach to this problem is: be certain you know the characteristics of the chemical or physical changes taking place and that these changes are being observed in an experimental environment which approximates or is some function of the environment to which extrapolation will be made.

The first part of this report considers the problem of converting data obtained in the experimental program to some logical and usable set of relationships. The effect of changing the size and geometry of equipment in which these data are obtained will be considered in the second portion as a direct exposition of extrapolation problems.

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Clark is a graduate chemical engineer from Northeastern University. His experience includes service with the Commonwealth of Massachusetts, Stone & Webster, Cities Service Refining Corp., the U. S. Bureau of Mines, and Israel Mining & Industries. Also he's taught and lectured in chemical engineering at the University of Pittsburgh and Catholic University.

Organization of Data

The most obvious experimental data observed are the effects of temperature, pressure, time and concentrations of reactants on the production of some desired material. This information is required in selecting an economical production level and a proper return on invested capital. It's also necessary for understanding the effect of changes in process variables.

Very often these effects can be conveniently expressed as functional relationships. This is desirable for calculating various design possibilities. Furthermore such functional relationships are particularly useful in programming computers which can then optimize many-variable systems.

To obtain meaningful and reliable data, one must plan at the start of the experimental program. Considerable information is available on the proper design of experiments, but the discussion of this subject is beyond the scope of this report. It's important that we emphasize though that preliminary planning must be done.

In correlating results considerable help can be obtained by fundamental information on kinetics of simple reactions. This procedure often permits the treatment of complex reactions by incorporation of simplifying assumptions. Another approach for complex reactions is to evaluate the component reactions separately and to combine the various steps into some over-all relationship which fits the experimental result. By such a technique it may be found that one of the intermediate or component reactions is the rate-controlling step and the entire complex may be treated as a function of this one reaction.

A less time-consuming procedure is to find some algebraic expression which fits the experimental data adequately. In many cases we aren't interested in the entire range of process variables but in a relatively limited area which appears economically attractive. By using these limits judiciously, simple relationships can sometimes be obtained which suit the particular area under investigation.

Kinetics of Simple Reactions

The simplest reaction involves a single molecule which reacts and evolves a product or products in a homogeneous system. The reaction rate depends on the concentration of the reacting material. This is a first-order reaction where the logarithm of reactant concentration is a linear function of the time at reaction conditions:

$$\ln\left(\frac{100}{100-x}\right) = kt$$

where k = reaction rate constant, in reciprocal time units.
x = percentage of material which disappears during time, t.
t = time in convenient units.

The rate constant may be related to temperature by the Arrhenius equation:

$$\ln k = \frac{-E}{RT} + \text{constant}$$

where k = reaction rate constant.
R = gas law constant.
T = absolute temperature.
E = energy of activation.

This is a straight-line relationship between the logarithm of k and the expression $-E/RT$.

If we can show by a moderate amount of experimentation that the particular reaction under study acts like a first-order reaction, we can represent our data by two very simple relationships. Since both these relationships give straight lines on semi-logarithmic paper, the extrapolation or extension of our data becomes a simple matter.

Hydrocarbon Thermal Cracking

A surprising number of reactions are pseudo first-order reactions. The thermal cracking of petroleum hydrocarbons, provided that the amount of decomposition is limited to below 20-25%, can be expressed as a first-order reaction. Nelson[1] presents a series of curves showing the reaction rate constants for various petroleum fractions and hydrocarbons. Some of these are shown in Fig. 1.

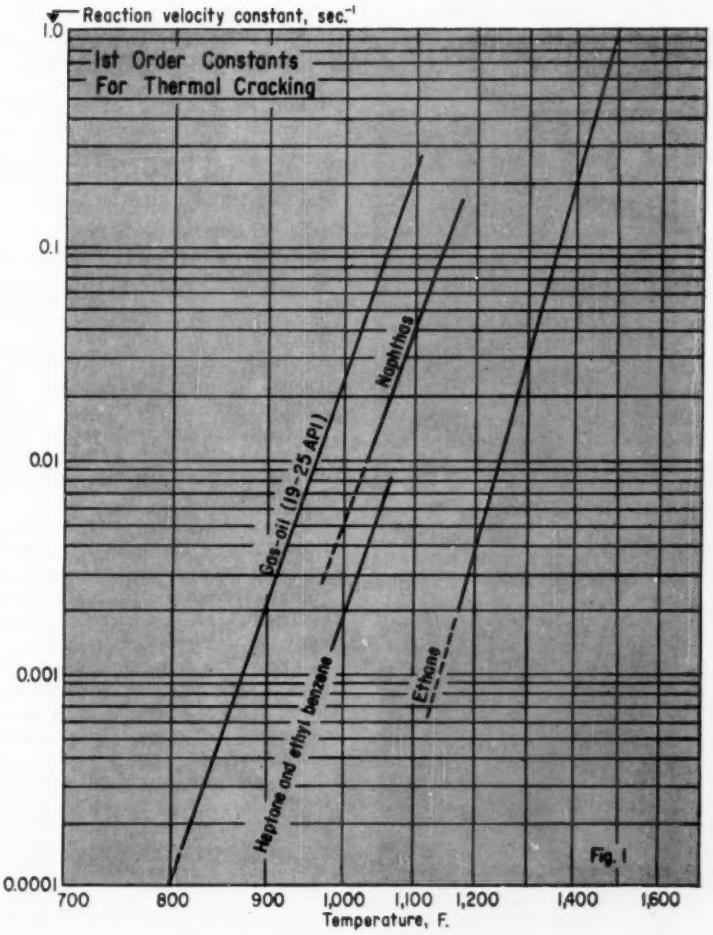
Many hydrogenation reactions are pseudo first-order, even though the reaction depends on two molecules and should not fit a first-order

plot. However, hydrogen is usually present in large excess and only the concentration of the molecule being hydrogenated is significant in determining the rate. Many polymerization and isomerization reactions follow a first-order reaction scheme as one might expect since these are often unimolecular reactions. Some behave differently when catalysts are employed.

The use of this correlating technique gives us additional information as to the type of resistance we must overcome in order to increase reaction rates. In Fig. 1, the slope of the lines give an activation energy in the 50 to 60 kilocalorie range. This indicates that at the conditions used for obtaining these reaction rate constants, there was little diffusional resistance.

Another interesting point is that the reaction of thermal cracking is not limited to the gas-oil fed to the system. All products produced by gas-oil cracking themselves undergo decomposition or cracking. We can imagine a process of consecutive first-order reactions, each reaction having its own reaction velocity constant. By combining these, we can calculate the concentration of any intermediate product —such as gasoline—in a thermal cracking process.

If we permit the gasoline to remain at cracking temperature for a long enough time, we would appreciably reduce the yield of this desirable product. From Fig. 1, we can see that the rate of gasoline (naphtha) decomposition is much slower than that of gas-oil at any chosen temperature—as indicated by a lower reaction rate constant. In industrial units gasoline destruction is prevented by distilling it from the reaction system as soon as it is formed and by controlling reaction time and temperature.



Kinetics of Coal Hydrogenation

Another interesting use of this technique is given by Weller and co-workers[2] in organizing data for the hydrogenation of coal in batch autoclaves. It's postulated that the conversion of coal to a hexane-soluble oil proceeds through two consecutive first-order reactions.

The reaction rate constant for the first step—the conversion of coal to asphalt—was obtained by plotting the logarithm of the percent of organic matter in the coal remaining against time as shown in Fig. 2. A quantity of this asphalt was isolated and the reaction rate constant for its hydrogenation similarly obtained from Fig. 3.

Both figures indicate the straight-line relationship between the logarithm of concentration and time. The slopes of the lines indicate the reaction rate constant since:

$$\ln (100 - x) = kt + \text{constant}$$

Knowing the two rate constants Weller uses the expression

$$A = \alpha C_o \frac{k_1}{k_1 - k_2} [e^{-k_2 t} - e^{-k_1 t}]$$

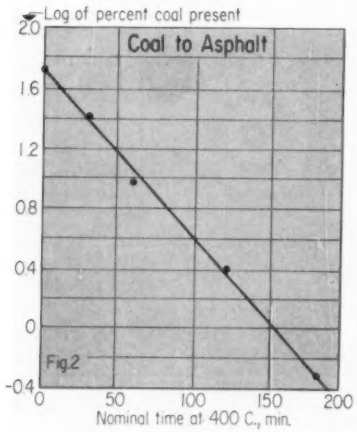
where A = asphalt present at time t.
α = fraction reacted coal converted to asphalt.
C_o = coal at initial time.
k_1 = rate constant for coal conversion.
k_2 = rate constant for asphalt conversion.

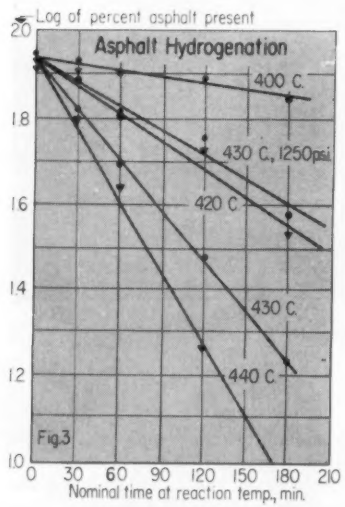
to calculate the concentration of asphalt present at any time.

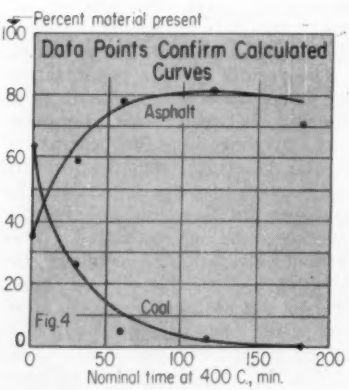
In Fig. 4 the calculated concentrations are plotted against time and compared with the experimental values. The agreement is reasonably good. Pelipetz et al,[3] extend this data to include the effect of catalysts and hydrogen pressure.

The results of data organization are to provide a convenient relationship between time, temperature, pressure and concentration. If the fraction reacted, pressure and temperature are stipulated, the time—or its function, the reactor volume—can be calculated. This type of calculation is seemingly independent of reactor size or shape. One tacitly assumes complete similarity of reaction conditions between large and small units. This similarity includes *all* conditions

Here's A Complex Reaction Correlated As First-Order







such as type of contact, extent of mixing, heat effects, reactant concentration, temperature, and pressure.

For an example of a complex situation where several rate constants for different reactions are involved, the reader is referred to Smith's text on kinetics.[4]

Techniques for Complex Reactions

In many cases—particularly for heterogeneous reactions where catalytic or reacting surfaces are involved—an empirical approach is needed to organize the data. The simplest type of expression of some generality might be the rate of reaction as a function of some power of the reactant, product or diluent concentration:

$$\text{Rate} = k(P_A)^n(P_B)^m(P_C)^o \cdots$$

where A and B might be reactants and C a product or diluent; P represents the partial pressure or concentration of a particular component in the reaction mixture; m, n, and o are numerical exponents; k is a rate constant for the reaction. Weller[5] suggests such an expression for many heterogeneous reactions.

In catalytic reactions, the exponents for very weakly absorbed products or diluents are often zero, simplifying the empirical rate expression. The exponents indicate the apparent order of the reaction with respect to the individual components and permit conventional experimental techniques for their determination (e.g., by varying concentration or partial pressure of one component at a time).

In many reactions it is found that the exponents do not change appreciably with temperature over the range being studied. Thus only the temperature dependence of the rate constant must be considered. The experimental work may be done on a very small section of a catalyst bed—a so-called differential reactor—and the rate expression integrated over a large reactor in which both concentration and temperature may vary.

A more elegant and time-consuming approach is to postulate probable mechanisms for a catalytic reaction, set up rate equations for the steps involved in each probable mechanism, and determine which of these equations best fits the experimental data. This procedure assumes that one step in the series is rate-controlling and its rate equation fits the over-all reaction.

Weller[5] discusses this approach and its basis and compares the accuracy of these rate equations with empirical equations of the form given above. For detailed description and examples of this type of data evaluation, the reader may consult Hougen and Watson's text.[6]

In general the simplified approach suggested by Weller, though empirical, is preferred for pilot-plant work. The primary purpose of data organization for a chemical reaction is to provide some functional relationship between time and amount reacted at various levels of temperature, pressure and concentration. This relationship can then be used to determine the size of reactor needed to evolve the desired amount of product in an industrial plant.

The type of data needed to determine the kinetic relationships discussed above can be obtained in laboratory or bench scale equipment. If we can set up these relationships which theoretically permit us to calculate reactor size for a desired throughput and yield, it's obvious that in some cases we can dispense with pilot-plant experimentation and can design a commercial reactor directly. However the primary problem in such an extrapolation is the lack of assurance that identical conditions will still exist as reactor size is increased. While minor variations as a function of size may not affect an extrapolation of one order of magnitude, these variations can grow to serious proportions in the jump of several orders of magnitude from laboratory to commercial units.

Data for Physical Processes

Similar techniques are applied to processes which do not involve chemical reaction. Here a diffusional resistance is usually encountered and the functional relationships are often empirical. Data are obtained on the time required for drying, mixing, absorption, solution or flotation under different conditions of temperature, pressure and concentration.

As in a chemical-reaction process, we attempt to evolve a functional relationship between time and a certain desired effect. The time may be expressed as heat transfer area, height of packed column, vol-

ume of flotation cell or size of drying chamber needed for a certain volume or weight of material to be processed per unit time. Still it's a time-rate relationship dependent on the same variables as those which affect rates of chemical reactions.

Time in Experimental Units

In the preceding discussion time has been repeatedly pointed out as a critical and important factor. Our chemical process industry has thrived through the use of highly productive, large, efficient units. The time required for a reaction or process operation measures the potential productivity of a capital investment and the fixed operating costs per unit of product. Hourly or daily throughput is merely the reciprocal of reaction or process time. A variation of 10-20% in productivity for a given industrial plant can create very large differences in its profitability. It is obviously important that we understand the inherent errors in the experimental determination of this variable.

The simplest type of reaction experiment uses a batch autoclave in which reactants are placed and kept at a given temperature and pressure for a certain period of time. The autoclave is then opened, and the extent of reaction is determined by analysis. It sounds simple. But the periods during which the autoclave is heated to reaction temperature and—after the reaction time—cooled so that it may be opened involve reactions at conditions other than those selected for investigation. If we know the effect of temperature on reaction rate we can convert the time spent at the lower temperatures during heating and cooling to an equivalent time at the desired reaction temperature. A similar adjustment may be necessary if pressure varies during the reaction period.

Usually these adjustments are minor since reaction rates are slower at the lower temperatures encountered during heating-up and cooling-down periods, but there are other possibilities. For exothermic reaction portions of the reaction mass may be heated to temperatures considerably higher than desired because of poor heat transfer. Then the corrections become quite significant. In addition, formation of undesirable products may result. Thus, there are problems of determining reaction time even in a simple non-flow system.

In a flow system, we have the same problem of adjusting for variations in temperature and pressure. Kandiner et al,[7] in determining time and temperature values for a coal hydrogenation pilot plant have presented a convenient method for tabulating and calculating these adjustments.

Another problem in a continuous system is the effect of expansion or contraction of reacting mixture volume during the reaction. A contraction of volume increases the time spent in the reactor, while an expansion decreases this time. Brinkley[8] discusses a mathematical approach for correcting reaction time for such variations.

The usual technique is to disregard these factors and to use space velocity instead of reaction time. For ideal conditions this value is the reciprocal of reaction time and is expressed as volumes of feed per volume of reactor or catalyst bed per unit time. In cases where the feed to the system is a partly vaporized liquid, weight or volume of the liquid per unit time per volume of reactor (or per weight or volume of catalyst) is a time measure.

Another time measure is that of "space-time-yield"—expressed as product (volume or weight) per volume of reactor per unit time. This value is a more complex one, involving possible reaction and destruction of the desired product as well as its formation. Therefore it often shows a maximum, which is the preferred operating point for an industrial plant since it represents maximum product yield per unit of investment in reactor and catalyst.

Another important problem in reaction-time measurement is the conversion of data from batch to continuous operation. Most engineers realize that in a turbulent continuous system some portions of the reactants spend more time within the reactor than others; there's always a certain amount of by-passing. Ham and Coe[9] and McMullin and Weber[10] evaluate this problem and calculate the effect of using one or a multiplicity of completely stirred reactors on the reaction results for different order reactions. Both these results are for series of vessels of equal size. Kandiner[11] extends these equations to include series of vessels of unequal sizes and evaluates purging times and sampling lags.

Obviously if one assumes piston-type flow, the time spent in a reactor can be easily calculated by dividing the reactor volume by the volumetric throughput. If we have four 1000-gallon tanks in series, and a flow rate of 100 gal./min., it will require 4000/100 = 40 minutes to displace the content of the four tanks assuming plug-like flow and no mixing within the tanks.

If we assume complete mixing in each of the four tanks and the same flow rate, it would require 66 minutes to achieve 90% displacement of the original content of the four tanks. If we use one stirred tank of 4000 gallons and the same flow rate, the time required for 90% displacement becomes 96 minutes, while for plug-flow only 40 minutes again is required. These results are calculated from curves presented by Kandiner[11] and give some indication of the effect of using stirred reactors.

Scale-Up Techniques

Most chemical engineers have become accustomed to making extrapolations of data from small laboratory-scale experiments to large-scale industrial applications. The entire fund of information compiled by the study of unit operations consists of such extrapolations. Each time an engineer uses a Reynolds number to calculate a pressure drop he is, in effect, extrapolating data from the laboratory results of Reynolds, Stanton and Powell, Nikuradse and a host of other experimenters who have developed the correlations currently in use. This type of extrapolation has become so well-accepted that it is not even considered to be an extrapolation process.

We are all familiar with less-understood unit operations for which our correlations are not as accurate. This is another way of saying that we find them more difficult to extrapolate. When chemical reactions are combined with a unit operation, our difficulties are increased—the extrapolation is more involved.

As previously stated, the first problem is to understand the effects of all process variables.

A. Cylindrical Tube Scaled-Up With . . .

Geometrical similarity—linear dimensions of large tube r times those of small. Dynamic similarity—Reynolds numbers equal in both tubes.

Parameter	Small System	Large System
Internal diameter	d	$D = rd$
Length	l	$L = rl$
Velocity	u	$U = u/r$
Volumetric throughput	$q = \frac{\pi}{4} d^2u$	$Q = rq$
Reactor volume	$v = \frac{\pi}{4} d^2l$	$V = r^3v$
Contact time	$t = v/q = l/u$	$T = V/Q = r^2t$
Surface area	$s = \pi dl$	$S = r^2s$
Surface area/volumetric throughput	$s/q = 4l/du$	$S/Q = r(s/q)$

Derivations

For equal Reynolds numbers and the same fluid in both the tubes, the Reynolds numbers reduce to:

$$du = DU = rdU$$

or

$$U = u/r$$

The second problem is to realize the changes caused by increasing the scale of our operation to the industrial unit. We'll consider here several typical examples which may assist in solving other problems.

Criteria for Scaling Up

In order to properly scale up a chemical system we must set up some basis for maintaining a relationship between the results in a small system and those to be predicted for the larger system. We have previously presented techniques for evaluating yields of desired product as a function of throughput and process variables.

It's been mentioned that some reaction velocities depend more on physical or diffusional conditions than chemical reaction rates. In many endothermic reactions the reaction rate may depend on the rate of heat transfer. For others the rate may depend on diffusion of products or reactants through a gaseous or liquid film. For still others the important factor is only the rate of the chemical reaction itself.

The effect of temperature on the over-all reaction rate is one guide to determining the critical or rate-controlling step. Similarly, the effect of added turbulence determines the extent of diffusional or other film-type resistance.

Considerable information has been published on setting some basis of similarity for the transference of results from small to large equipment. Damkohler[12] suggests five dimensionless groups which can be used as a means of equating conditions in large and small reactors. These would be used to denote reaction similarity as we utilize Reynolds numbers to denote equivalence of turbulence in various systems.

Johnstone[13] discusses the work of Damkohler and suggests that the number of dimensionless groups can be reduced by including the Arrhenius relationship which relates reaction rate and temperature. He suggests the following groups for homogeneous and heterogeneous chemical reactions.

Homogeneous reactions — For first order reactions the dimensionless groups are: (x_1t) and (E/RT)

where x_1 = a constant having the dimensions of the velocity constant for a first-order reaction, T^{-1}.
t = reaction time, T.
E = energy of activation, ML^2T^{-2}.
R = gas constant, $ML^2T^{-2}\theta^{-1}$.
T = absolute temperature, θ.

The dimensions are the familiar M, L, T, θ representing mass, length, time and temperature.

For reactions of higher order the groups become: $(X_na_1 \ldots . a_nt)$ and (E/RT), where n denotes the order of the reaction and $a_1 \ldots . a_n$ denote concentrations of reactants. The dimensions of X vary with the reaction order as do the dimensions of the velocity constant.

Heterogeneous reactions — Here a term is introduced to represent the quantity of surface available to the reaction and the dimensionless groups become:

$(X_na_1, a_2 \cdots a_n\sigma t)$ and (E/RT)

where X_n = constant with varying dimensions depending on apparent order.
E = apparent energy of activation, ML^2T^{-2}.
R = gas constant, $ML^2T^{-2}\theta^{-1}$.
T = absolute temperature, θ.
a_1, a_2 = concentrations of substances $A_1, A_2 \cdots, ML^{-3}$.
t = reaction time, T.
σ = interfacial surface area per unit volume of system, L^{-1}.

If the dimensionless groups for a large and small system are equal, then chemical similarity is considered to exist. This is achieved in a homogeneous system when the initial concentrations, time and temperature are equal. For a heterogeneous system the product $\sigma\ t$, initial concentrations, and temperature shall be equal at all points.

Damkohler achieves similar results in considering this problem. His requirements for chemical similarity are: time of reaction should be equal; temperatures should be equal; the surface heat losses from large and small systems should be the same proportion of the total heat input. Actually the last requirement refers to those

scale-up cases where heat transfer rates affect the control of temperature.

Thus far we have not considered at all the problems of those reactions in which diffusion—or "dynamical resistance" as Johnstone[13] suggests—is a controlling factor. Laupichler[14] considers the rate of the water-gas reaction, a heterogeneous second-order reaction, to be governed by a term equivalent to $A \sigma t$. The value $1/A$ is the total resistance to the reaction and consists of two terms:

$$\frac{1}{A} = \frac{1}{kC_m} + \frac{\delta}{D}$$

where k = velocity or rate constant of the reaction.
C_m = mean concentration of water vapor.
δ = thickness of streamline film on catalyst surface.
D = diffusion coefficient of carbon monoxide through the gas film.

Thus $1/kC_m$ is the "chemical resistance" which will vary only with temperature and reactant concentration, while δ/D is the dynamical resistance which will be affected by the degree of turbulence or by changes in Reynolds number. If the reaction depends on a heat transfer rate, the dynamical resistance may be expressed as δ/K, where K is the thermal conductivity of the fluid film.

The relative effect of each resistance is an important scale-up consideration. In effect this statement reverts to our previous discussion of the "rate-controlling" step, but more definitively and exactly.

If the chemical reaction rate is low, the resistance due to dynamic considerations may be disregarded. Then the scale-up problem may only require that we maintain similar temperatures and contact times in the small and large plant with dimensional and dynamic considerations being disregarded.

At high temperatures or with rapid reactions, the problems of dynamic similarity in both large and small plants are the critical ones. The most difficult situation occurs when both resistances are appreciable. Then the design of the pilot-plant reactor usually must be a compromise between competing similarities, and therefore extrapolation becomes more difficult.

Effects of Changes in Size

All engineers have at some time or another considered the effect of enlarging an experimental unit to increase its permissible production. Often the effects are predictable and understandable; occasionally an "exception" is encountered. Usually the so-called exception is merely a case where all effects of the enlargement were not considered nor completely understood. To illustrate this possibility, we have calculated several examples of the effects of size changes.

Example A—The first example shown in the table considers two cylindrical tubes, the larger of which is r times the smaller. We have postulated geometric similarity, which requires that the ratio of any corresponding dimensions in the two systems be equal to the size ratio r. If we further postulate dynamic similarity (equal Reynolds numbers), we completely fix all characteristics of the system.

The velocity in the large tube is $1/r$ times the velocity in the small tube. Also the contact time in the large tube is r^2 times that in the small tube, for these conditions.

Let us consider what this means in regard to scale up of a pilot-plant reactor which is a 1-inch diameter tube 5 ft. long. For a 10-fold increase in size ($r = 10$), we would have a 10-inch diameter reactor 50 ft. long with a volumetric throughput 10 times the smaller unit. This would give us equal Reynolds numbers in both small and large units, but a contact time in the large unit 100 times that in the smaller.

If we want to get equal contact or reaction times in the large and small reactors, the length of the larger tube must be reduced by a factor of 100 to 0.5 ft. However a reactor with these dimensions (10-in. diameter by 0.5 ft. long) is not too satisfactory. We can see at once that if we desire to maintain constancy of reaction time and Reynolds number in a scale-up, the small tubular unit must be longer than the larger unit.

In the example we have a reaction or physical change in which dynamical resistances are of importance. If we're concerned with heat transfer through the wall of the small reactor, another problem arises in the case of the larger unit. For example, the wall surface area in the larger reactor for equal contact times expressed as surface area per volumetric throughput of reactants is $\frac{1}{10}$ that of the small system. Thus we must insert additional heating or cooling surface area into the larger reactor to obtain equivalent results.

Example B—For this example we've chosen a system described by Johnstone and Thring[15] in their text on scale-up methods. Here we have a system in which reactants are fed into a tube where a homogeneous reaction is taking place. The effect of turbulence is considered to be negligible. For chemical similarity, though, the temperature and contact time must be identical in both large and small units. In order to have equal contact times, the initial and final pressures should be the same in both large and small units.

In Example B we've shown the relationships between feed rates, diameter and coil length that must exist for the assumed conditions. It's evident that no geometrical or dynamic similarity exists. The ratio of large and small diameters is considerably greater than the ratio of lengths of the large and small coils. Though the Reynolds numbers are different, it's assumed that turbulent flow exists in both coils.

If we examine Example B a bit more critically, we can appreciate that even for chemical similarity there's chance of scale-up problems. If we assume a volumetric throughput ratio (Q/q) of 100 (i.e., large system to handle 100 times the throughput of the small unit), the diameter ratio (D/d) of the tubes would be $(100)^{0.425} = 6.75$. The length ratio (L/l) would be $(6.75)^{0.41} = 2.18$.

The (surface area per unit volumetric throughput) ratio—$(S/Q)/(s/q)$—calculates as $1/6.75 = 0.148$. And the Reynolds number ratio $(N_{Re}/n_{Re}) = (6.75)^{1.41} = 14.8$.

The heat transfer coefficient would be greater in the larger system, but not sufficiently greater to compensate for the smaller area available per unit of throughput. This can be calculated by assuming that the Nusselt number will vary as the 0.8 power of the Reynolds number.

If (HD/hd) is the ratio of Nusselt numbers for the two tubes:

$$\text{Since} \quad \frac{(HD/hd) = (14.8)^{0.8} = 8.65}{(D/d) = 6.75,}$$

$$(H/h) = \frac{8.65}{6.75} = 1.28$$

$$\text{Then} \quad \frac{(HS/Q)}{(hs/q)} = (1.28)(0.148) = 0.19$$

If the reaction under considera-

B. Circular Cracking Coil Scaled-Up With . . .

Turbulent flow in both coils.
Equal pressure drops, temperatures, and contact times in each coil.

Parameter	Small System	Large System
Internal diameter	d	$D = d(Q/q)^{0.414}$
Length	l	$L = l(D/d)^{0.41}$
Velocity	u	$U = u(D/d)^{0.41}$
Volumetric throughput	$q = \frac{\pi}{4} d^2u$	$Q = q(D/d)^{2.41}$
Reactor volume	$v = \frac{\pi}{4} d^2l$	$V = v(D/d)^{2.41}$
Contact time	$t = v/q = l/u$	$T = L/U = t$
Surface area	$s = \pi\, dl$	$S = s(D/d)^{1.41}$
Surface area/volumetric throughput	$s/q = 4l/du$	$S/Q = (s/q)/(D/d)$
Reynolds number	$n_{Re} = q(4\rho/\pi\, d\,\mu)$	$N_{Re} = n_{Re}(D/d)^{1.41}$

Derivations

For equal contact times: $L = l(U/u)$ (1)

For turbulent flow, the friction factor can be expressed as a function of the Reynolds number: $f = 0.04(n_{Re})^{-0.16}$ and $F = 0.04(N_{Re})^{-0.16}$ (2)

For turbulent flow and equal pressure drops, Darcy's equation gives: $flu^2/d = FLU^2/D$ (3)

Combining equations (1), (2) and (3) gives: $U = u(D/d)^{0.41}$ and $L = l(D/d)^{0.41}$ (4), (5)

From equations (4) and (5), other parameters for Example B are derived.

tion is one which requires addition of heat—such as thermal cracking of petroleum fractions—the larger area available for heat transfer per unit quantity of reactants in the pilot plant would permit a lower temperature differential across the tube wall than that needed for the larger unit. This condition would exist in spite of the slightly higher film heat transfer coefficient in the larger unit.

The higher wall temperatures needed in the larger unit may cause coking at the tube wall and other undesirable effects not observable in the pilot-plant unit. To avoid such a possibility, additional test work should be included in the pilot-plant program to investigate this effect of higher tube-wall temperatures on operability and product distribution.

Heterogeneous-System Examples

While conditions for chemical similarity have been discussed for heterogeneous reactions, it should be appreciated that quantitative relationships for reaction velocity in such systems are not well-established. It's often difficult to obtain equations governing the adsorption of products and reactants at catalyst surfaces. Often dynamical resistance is the primary rate-controlling factor. Another problem in heterogeneous reactions is that the interfacial area may be mobile and variable, as in a liquid-gas system. In such reactions it's difficult to ensure that a relationship is maintained between the pilot plant and the industrial system.

Example C-1—Here we are considering a heterogeneous system in which there's a fluid reacting on a solid catalyst. In this case it's possible to calculate the solid surface interface which has been designated as σ. As indicated in Example C-1, geometrical similarity has been assumed extending even to the diameter of the catalyst granules.

If it's desired to maintain chemical similarity—equality of the dimensionless group $(X_n a_1, a_2 \ldots . a_n\ \sigma\ t)$—the contact time in the smaller system is shorter than that in the larger by the linear dimensional ratio of the two systems. This is compensated by the greater catalyst interfacial surface area in the smaller system. The velocity in the two systems is identical.

There are some obvious difficulties in making the above analysis. The assumption that the geometric surface of the catalyst is the important criterion governing the extent of reaction is open to question. In many cases the surface area is more a function of catalyst weight or actual volume than of geometric surface.

Manufacture of two sizes of catalyst granules often introduces particle density differences for the two sizes with major differences in activity. For this reason it's wiser to utilize commercial catalyst particles in a pilot-plant program. This does not allow complete geometric similarity, but it eliminates a source of difference that's often difficult to analyze. It's assumed that the ratio of catalyst-bed pressure drop to inlet pressure is small enough to have an insignificant effect on contact time.

Example C-2—It's important and worthwhile now to consider the heat transfer and fluid film conditions of the system in Example C-1, as shown in Example C-2. Here the industrial unit is an uncooled reactor where the only heat removal is through natural convection from the external wall. The major resistance to heat removal is probably represented by the coefficient of natural convection.

Thus, as developed in Example C-2 in the table, for uninsulated reactors with geometrical and chemical similarity the heat loss per unit of throughput is the same in the large and small units. This is an important factor in simplifying scale-up of such a unit. Of course

C. Heterogeneous Reaction System

1. Cylindrical reactor with . . .

Geometrical similarity, including diameter of solid catalyst granules—linear dimensions of larger system r times those of smaller system.

Chemical similarity—equal dimensionless groups $(X_n a_1, a_2 \ldots a_n \sigma t)$.

Any type of reactor cooling—e.g., natural convection from reactor outer shell, water jacket surrounding reactor, or tubes or coils inside reactor.

Parameter	Small System	Large System
Internal diameter	d	$D = rd$
Length	l	$L = rl$
Reactor volume	$v = \frac{\pi}{4} d^2 l$	$V = r^3 v$
Catalyst granule diameter	d_e	$D_e = rd_e$
Catalyst surface area per unit reactor volume	σ_s	$\sigma_l = \sigma_s / r$
Volumetric throughput	$q = \frac{\pi}{4} d^2 u$	$Q = r^2 q$
Velocity	$u = 4q/\pi d^2$	$U = u$
Contact time	$t = v/q$	$T = rt$

Derivations

For chemical similarity, and equal temperatures and reactant concentrations ($X_n a_1, a_2 \cdots a_n$ is constant), then the value of the dimensionless group σt must be equal in both systems.

Contact time in small system $= t = v/q$

Contact time in large system $= T = V/Q = r^3 v/Q$

Also, $\sigma_s t = \sigma_l T$; or $\sigma_s v/q = \sigma_s / r(r^3 v/Q)$

Thus, $Q = r^2 q$, and $T = rt$

2. Same system as in C-1 with . . .

Reactor cooled only by natural convection from external wall.

Parameter	Small System	Large System
External surface area	s	$r^2 s$
Surface heat loss coefficient/external area	h	h
Surface heat loss	hs	$r^2 hs$
Heat loss/volumetric throughput	hs/q	$r^2 hs/Q = hs/q$

Derivations

Major heat removal resistance is represented by a natural convection coefficient. The only internal condition affecting this is temperature, which is equal in both systems. Therefore, we can assume equal heat loss coefficients.

3. Same system as in C-1 with . . .

Reactor cooled externally by surrounding water jacket.

Parameter	Small System	Large System
Modified Reynolds number	$n_{Re} = \left(\frac{d_e q}{d^2}\right)\left(\frac{4\rho}{\pi\mu}\right)$	$N_{Re} = rn_{Re}$
Heat transfer coefficient (b = a constant)	$h = (b/d)(n_{Re})^{0.7}$	$H = r^{-0.3} h$
Heat transferred per unit volumetric throughput	hs/q	$HS/Q = r^{-0.3}(hs/q)$

Derivations

Gas film is major heat transfer resistance—its coefficient as function of modified Reynolds number:

For small system: $h = (b/d)(n_{Re})^{0.7}$; b = constant and, $n_{Re} = (d_e u\rho/\mu) = (d_e q/d^2)(4\rho/\pi\mu)$

For large system: $H = (b/D)(N_{Re})^{0.7}$; b = constant and, $N_{Re} = (D_e Q/D^2)(4\rho/\pi\mu) = rn_{Re}$

Then: $(H/h) = (d/D)(N_{Re}/n_{Re})^{0.7}$ and, $H = r^{-0.3} h$

D. Heterogeneous Reaction System Scaled-Up With . . .

Chemical similarity.
Catalyst particles of equal size in large and small systems.
Volume of larger system r times volume of smaller system.

Parameter	Small System	Large System
Reactor volume	v	$V = r^3v$
Catalyst diameter	d_c	$D_c = d_c$
Catalyst surface area per unit reactor volume	σ_s	$\sigma_l = \sigma_s$
Volumetric throughput	q	$Q = r^3q$
Contact time	$t = v/q$	$T = V/Q = t$
Velocity		
Geometrical similarity	$u = 4q/\pi d^2$	$U = ru$
Equal velocities	$u = 4q/\pi d^2$	$U = u$
Internal diameter		
Geometrical similarity	d	$D = rd$
Equal velocities	d	$D = r^{1.5}d$
Length		
Geometrical similarity	l	$L = rl$
Equal velocities	l	$L = l$

Derivations

For chemical similarity σt terms must be equal (see Example C).

Contact time in small system $= t = v/q$

Contact time in large system $= T = V/Q = r^3v/Q$

And, $\sigma_s t = \sigma_l T = \sigma_s T$

Then, $v/q = V/Q = r^3v/Q$

Thus, $Q = r^3q$ and $T = t$

this example assumes that catalyst activity is proportional to catalyst geometric surface, and that our dimension group really signifies chemical similarity.

Example C-3—A different result is obtained if the catalytic reactor requires cooling through the use of water jackets or water-tubes within the catalyst bed, as in Example C-3.

Under such conditions the major resistance is represented by the gas film coefficient, which is a function of a modified Reynolds number within the catalyst bed. Leva et al.[16] have correlated the gas film coefficient for cooling in packed tubes by an approximate relationship:

$$h = 0.4\,\frac{k}{d}\left(\frac{d_c G}{\mu}\right)^{0.7}$$

where h is the film coefficient based on tube surface; d is the tube diameter (reactor in this case); d_c is the particle diameter (catalyst granule here). Thus $\left(\frac{d_c G}{\mu}\right)$ is a modified Reynolds number.

From the relationships derived for this example, in a large unit 10 times the linear dimension of a pilot-plant system, the heat transferred through water cooling of the external shell per unit volumetric throughput of reactants would be $10^{-0.5}$ or about $\frac{1}{3}$ that obtained in the small unit.

Example D—Here we've eliminated the assumption that catalyst activity and geometric surface area are identical by using similar catalyst particles in both small and large units. We have retained the volume ratio between units of r^3 used in Examples A through C.

For equal contact times the volumetric flow rate in the large unit is r^3 times the flow rate in the small. For geometrical similarity (equal length to diameter ratio for both reactors), a higher velocity is obtained in the larger unit. This would result in higher Reynolds numbers and different heat transfer rates and pressure drops for the larger unit. However, if the diameter ratio of the two units were $r^{3/2}$ and the units were equal in length, then velocities would be equal as would the Reynolds numbers.

For two tubes of geometric similarity, charged with identical catalyst particles, the heat transfer conditions are not similar. The surface heat loss by natural convection per unit of throughput in the smaller unit would be r times the amount in the larger unit.

The heat transfer coefficient for the gas phase in the larger unit would be $r^{-0.3}$ times the smaller unit. The heat transferred per unit volumetric throughput in the smaller unit (for gas-phase resistance controlling) would be $r^{1.3}$ times that in the larger unit. This calculation is made as shown in Example C, and assumes that the tube wall is used as the cooling surface.

Use of industrial catalyst particles in a small reactor requires some care in avoiding excessive "wall effects." The diameter of the catalyst tube should be at least six to eight times the diameter of the particles. Since industrial catalyst pellets are usually at least $\frac{1}{4}$ inch to $\frac{3}{8}$ inch in diameter, the experimental unit must therefore not be smaller than 2 to $2\frac{1}{2}$ inches in internal diameter. This requirement is similar to that suggested for pilot-plant fractionator or absorber column packing.

Example D can also be considered from the point of view of a fluidized catalytic reactor. The importance of the fluidized technique has been amply demonstrated in many processes. Usually the catalyst particles

are identical in both industrial and pilot-plant units.

If we consider the situation for identical catalyst in geometrically similar tubes as shown in Example D, we realize at once that the difference in velocity is a very important factor. Tests made in a small reactor cannot always be scaled up.

For a diameter ratio of 20-30 between small and large units, the velocity in the large unit will be 20-30 times that in the smaller unit. This would be beyond the fluidization range for the catalyst particles, and they would be carried out of the larger unit. A decrease in velocity would result in a different contact time for the large unit.

This situation has been resolved in two ways. Some experimental units have been operated with mechanical stirring of the fluidized bed to permit using low velocities. Another alternative is to have the experimental unit sufficiently long to avoid excessive velocity variations between large and small systems.

Unit Operations Scale-Up

While the discussion on scale-up techniques has been oriented towards systems involving chemical reactions and equipment for such processes, the same general approach is applicable to scale-up of unit operations and other processes involving physical changes. The difficulties encountered in scaling up heat transfer and other diffusional and transport processes has been mentioned in the discussion. We can use Examples A through D to evaluate the scale-up effects on heat transfer or other diffusional processes where the film thickness at a surface is the controlling factor. The Reynolds number can be considered as a measure of this thickness.

A similar approach to the problems of scaling up mixing equipment has been presented by Jordan.[17] In his illustration the Nusselt group with the film coefficient of heat transfer is found to be a function of the modified Reynolds number. He points out that the ratios of impeller speeds in two geometrically different systems depends on the functional relationships between the desired result (Nusselt group here) and the Reynolds number. He thus indicates that the common approach to scale-up of mixing equipment—constancy of power input per unit volume—may not always hold.

Only if the desired result varies as the 0.75 power of the Reynolds number will the power input per unit volume be identical for both large and small units. Often such a relationship does hold—e.g., most heat transfer rates in mixing equipment do vary as the 0.6-0.8 power of the Reynolds number.

Unit operations involving equilibrium stages or plates such as fractionation, absorption or extraction can usually be projected to the industrial scale without pilot-plant study as we've mentioned before.[18]

The use of simple models is a "scale-down" technique which is applicable to many physical processes. Again the unit operations for which these methods can be used have been discussed.[18] In all cases we should be certain that our model is a truly representative one. For example the use of a unit filtration area is a quite common method for evaluating the performance of an industrial filter. The particles and the fluid-solid mixture fed to our pilot-plant system must be identical to those processed on the industrial scale. The geometry of the filtration unit and the turbulence in the slurry chamber are important.

Extrapolating Corrosion Effects

Another important area for pilot-plant investigation is the determination of economical materials of construction. In many cases, the pilot plant is built with this factor as its primary purpose. The step from the glass equipment of the laboratory to the use of standard construction materials is important.

There is a tendency to oversimplify the corrosion problem in the pilot plant by considering that the effects of corrosion and erosion in the pilot plant are exactly indicative of the industrial-scale effects. The problems of the chemical reactions causing deterioration of materials of construction must be considered in the same manner as the reactions which form the products. Scale-up of various items of equipment may change the velocities and concentrations of materials in such a direction as to seriously increase the rates of corrosive reactions. Variations in heat transfer conditions on scale-up may result in higher metal temperatures at some points.

For example, consider a simple boiler tube in a power plant. The type of water passing through this tube, its velocity of flow and the temperature can easily be simulated to evaluate the corrosion rate under operating conditions. It is much more difficult to simulate the heat transfer rate through the wall of the tube and the surface properties of the tube which exist under normal boiler operation. Yet these conditions probably affect corrosion rates of tubes in commercial boilers.

Design Pilot for Scale-Up

Size variation effects between experimental and industrial units indicate the importance of considering scale-up problems in pilot-plant design. One can simplify these problems by evaluating the situation in advance. The scope of this discussion is not sufficient to include all factors for every process. We'll tell some of the difficulties which may be encountered trying to satisfy all conditions dictated by the various similarities. One must realize that similarities are not exact values, particularly for heterogeneous reactions.

Bosworth[19] discusses the problem of the difficulty of satisfying all the dimensionless terms suggested by Damkohler. He concludes that it's only possible to obtain complete similarity between experimental model and industrial prototype by varying catalyst activity or by using geometrically dissimilar units. The same result has been demonstrated in our discussion. The design of the model and its relation to the industrial unit will vary with the dominant factor which regulates the process.

In each of our examples we've considered a different situation and evaluated the parameters and their effects. In the first system the design criterion was geometric and dynamic similarity. It was shown that the experimental system—a tubular unit—should be considerably longer than the industrial unit to permit equal contact times. If heat loss from the tube surface is a critical factor, adiabatic windings will be needed to control this loss in the smaller unit due to its larger surface area per unit volume.

A similar situation in the length of the pilot-plant unit was noted in the second system, where equal

pressure drops across the reactor were maintained in both systems. Again in the last example we noted considerable advantage in a pilot-plant reactor of greater length. The only exception was Example C.

Most pilot-plant reactors are too short to obtain simplified scale-up relationships. A long, thin experimental reactor does introduce operating problems of temperature control and difficult clean-up and maintenance, but the ease of scale-up is considered much more important in the over-all picture. Actually there's considerable advantage in the use of a pilot-plant reactor of length equal to the projected industrial unit. This is equivalent to using an element of the industrial unit as our model or test system.

Many industrial processes have been developed by such techniques. The first Houdry cracking reactors were essentially a bundle of small tubes containing catalyst, heated by a fused salt bath. The German Fischer-Tropsch reactors were similarly designed as was the Downs converter for phthalic anhydride production. In all these cases the experimental unit consisted of a single tube while the industrial reactor had many tubes, each identical to or larger than the original experimental unit. Both reaction time and heat or material transfer were important factors. These cases are similar to our Example D, where we find that both velocity and contact time can be kept identical by tubes of similar length and suitable diameter-throughput-volume ratios.

Tips for Using Elements

Industrial unit elements as test systems are often used for many unit operations. The common tubular heat-exchanger is made of a number of tubes—each easily capable of being an experimental system for finding the appropriate film coefficient. Screens and filters are designed based on the action of a section or unit area in an experimental system.

Care must be taken that the flow distribution and surface or wall effects are similar. It is simple to evaluate one tube of a tubular reactor or heat exchanger. Considerably more thought must be given to the experiment where the pilot unit is a section of a much larger diameter reactor. Though the wall of the experimental unit may be a heat transfer surface, it must be remembered that a different situation can exist in the larger unit if heat transfer surfaces of different shape and spacing are required.

Where highly exothermic reactions are being investigated, a good value to determine is the maximum distance which can be allowed between a catalyst particle and the nearest heat exchange surface. This value will eliminate much uncertainty about the safe design of the industrial unit. For an adiabatic reactor, the small unit must be designed so that the rate of heat loss can be controlled to simulate that of the larger unit with its lower surface per unit throughput.

Where heat must be supplied to the reactor, the problem is a bit more difficult. In an elemental model, the maximum allowable distance from a heating surface can be determined. For furnace design, one of the parallel furnace tubes can be used as a pilot unit. In the second article[20] in this series, such a case was described (the development of an acetic-anhydride-from-acetone-process). Here the same size furnace tube was used in the pilot plant and the large multi-tube production furnace.

In experimental work with dense-phase fluidized beds, velocity limitations imposed by such a system are an added factor. If in scaling up the experimental unit the length is increased, there's an excellent possibility that the velocity increase will cause excessive carryover. A further complication is decrepitation of catalyst particles. Again it's very important that the experimental-unit length approach that of the production unit.

Point-Conditions Important, Too

The same problems in the scale-up of chemical reactions must be solved also for physical changes. Where separation or transport processes must be evaluated on a pilot-plant scale, the techniques discussed for chemical reactions can be utilized.

In many cases, though, a more serious difficulty arises. Changes in size and geometry may affect the *average* conditions in a uniform and predictable manner. But the effect on conditions at some specific *points* may have unpleasant results.

An example of such a situation might be a corrosive reaction on the wall of the vessel or conduit. If conditions exist at some point in the system which increase the rate of such a reaction, serious failures in the industrial system can result. Another example is carbon formation in a high-temperature system. A point-condition may exist which can plug the system just as effectively as a major oversight in the over-all scale-up.

System scale-up is far from an exact science, although one certainly can use scientific techniques in its accomplishment. Possibly the need for some "guessing" and the satisfaction at occasionally guessing right are the spicy ingredients that attract so many of us to the problems of the pilot plant.

References

1. Nelson, W. L., "Petroleum Refinery Engineering," 4th Ed., p. 651, McGraw-Hill Book Co., Inc., New York (1958).
2. Weller, S., M. G. Pelipetz and S. Friedman, *Ind. & Eng. Chem.*, **43**, pp. 1572-1579 (1951).
3. Pelipetz, M. G., J. R. Salmon, J. Boyer and E. L. Clark, *Ind. & Eng. Chem.*, **45**, p. 806 (1952).
4. Smith, J. M., "Chemical Engineering Kinetics," pp. 62-66, McGraw-Hill Book Co., Inc., New York (1956).
5. Weller, S., *A.I.Ch.E. Journal*, **2**, pp. 59-62 (1956).
6. Hougen, O. A. and K. M. Watson, "Chemical Process Principles," Combined Volume, pp. 943-957, John Wiley & Sons, Inc., New York (1950).
7. Kandiner, H. J., R. W. Hiteshue and E. L. Clark, *Chem. Eng. Prog.*, **47**, p. 392 (1951).
8. Brinkley, S. R., Jr., *Ind. & Eng. Chem.*, **40**, p. 303 (1948).
9. Ham, A. and H. S. Coe, *Chem. and Met. Eng.*, **19**, p. 663 (1918).
10. MacMullin, R. B. and M. Weber, Jr., *Trans. A.I.Ch.E.*, **31**, p. 409 (1935).
11. Kandiner, H. J., *Chem. Eng. Prog.*, **44**, p. 383 (1948).
12. Damkohler, G., *Z. Electrochem.*, **42**, p. 846 (1936).
13. Johnstone, R. Edgeworth, *Trans. Inst. Chem. Engrs. (London)*, **17**, p. 129 (1939).
14. Laupichler, F. G., *Ind. & Eng. Chem.*, **30**, p. 578 (1938).
15. Johnstone, R. Edgeworth and M. W. Thring, "Pilot Plants, Models, and Scale-Up Methods," McGraw-Hill Book Co., Inc., New York (1957).
16. Leva, M., M. Weintraub, M. Grummer and E. L. Clark, *Ind. & Eng. Chem.*, **40**, p. 747 (1948).
17. Jordan, D. G., "Chemical Pilot Plant Practice," pp. 36-47, Interscience Publishers, New York (1955).
18. Clark, E. L., *Chem. Eng.*, **65**, June 2, 1958, p. 119.
19. Bosworth, R. C. L., *Trans. Faraday Soc.*, **43**, p. 399 (1947).
20. Clark, E. L., *Chem. Eng.*, **65**, June 2, 1958, p. 120.

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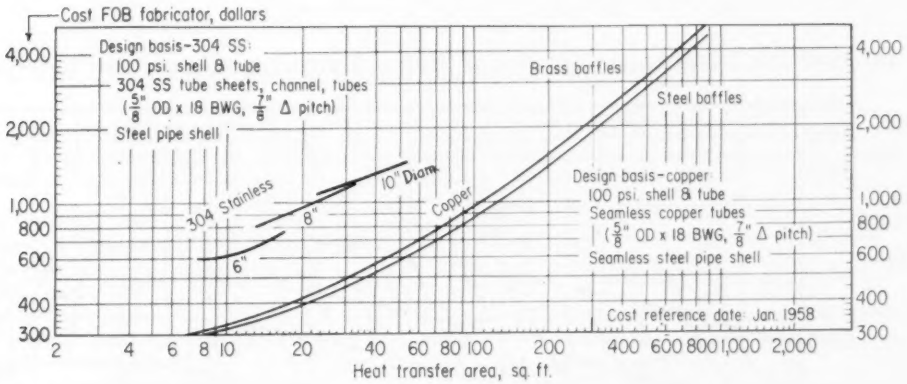

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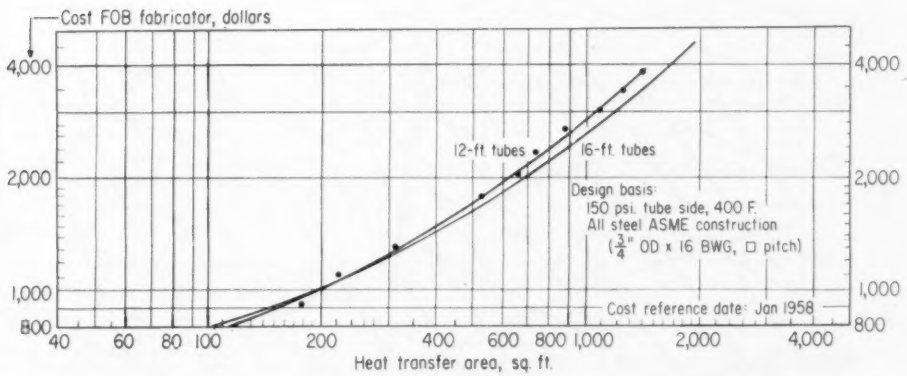

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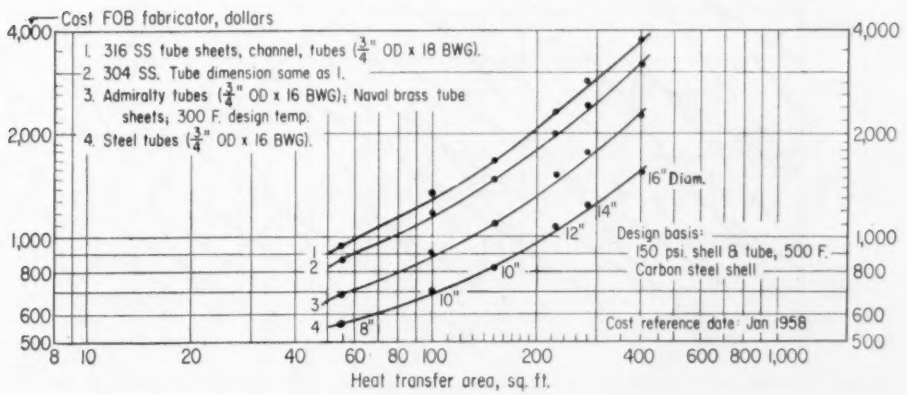
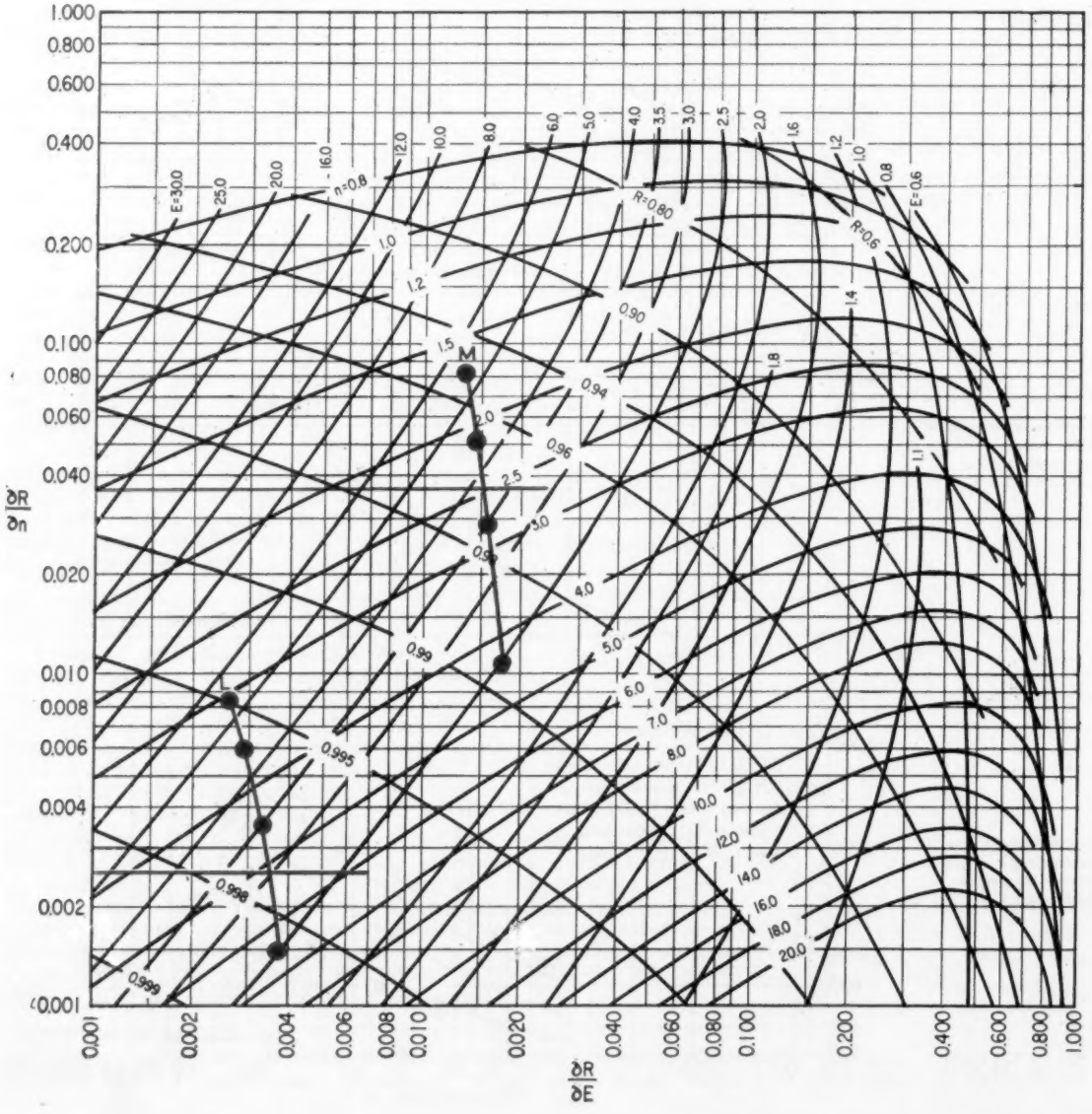


Use Graph to Design for

Intersection Gives Optimum No. of Stages, Extraction Factor and Recovery



Optimum Economic Extraction

Now you can determine optimum economic values for variables in countercurrent, multiple-stage operations. One graph solves the equations.

ROBERT S. OLSON, Project Leader, Research Dept., Dow Chem. Co., Pittsburg, Calif.

SOLVENT extraction, decantation and absorption are often set up as countercurrent, multiple-stage operations. Effectiveness of these operations is fixed by the feed ratio, distribution coefficient and number of theoretical stages.

You can determine optimum operating conditions for any of these systems by calculating the efficiency at several values of the operating variables. This is a long, tedious and time consuming procedure.

In many systems, you'll find the distribution is linear or nearly so; i.e., $y = mx$. This means you can find the optimum design point mathematically.

There's an equation[1] to calculate the optimum number of stages. Unfortunately, it's very complex and requires repetitive calculation.

Graphs are also available[2] for determining the optimum feed ratio and number of stages for extraction columns at a given recovery. These graphs are limited because of the assumptions made and because you must pick a figure for the recovery.

On top of this, neither the equation nor the graphs gives a design based on incremental investment.

Chart Solves Equations

When the distribution is linear, recovery R is related to the extraction factor E and the number of stages n by the Kremser relationship:[3, 4]

$$R = \left(\frac{E^{n+1} - E}{E^{n+1} - 1} \right) \tag{1}$$

Nomenclature

A	Feed rate of phase X, gpm.
B	Feed rate of phase Y, gpm.
E	Extraction factor, mB/A.
F	Feed.
I	Capital investment, $.
m	Distribution coefficient, y/x.
N	Terminal stage.
n	Number of theoretical stages.
R	Recovery, $(x_F - x_N)/(x_F - y_F/m)$.
r	Value of recovered material, $/day.
s	Cost of stages, $/day/$\Delta n$.
t	Cost of extraction factor, $/day/$\Delta E$.
X	Phase solute is removed from.
x	Concentration of solute in phase X, lb./gal.
Y	Phase solute is transferred to.
y	Concentration of solute in phase Y, lb./gal.

Here, the extraction factor $E = (mB/A)$ and recovery $R = (x_F - x_n)/(x_F - y_F/m)$. Taking the partial derivatives of Eq. (1) gives the optimum design points.

Optimum design with respect to the number of stages n:

$$\frac{\partial R}{\partial n} = \left[\frac{(E^{n+1})(E - 1) \ln E}{(E^{n+1} - 1)^2} \right] \tag{2}$$

Optimum design with respect to the extraction factor E:

$$\frac{\partial R}{\partial E} = \left[\frac{(nE^{n+1}) - (n + 1)(E^n) + 1}{(E^{n+1} - 1)^2} \right] \tag{3}$$

In Eq. (2), we have the optimum recovery with respect to the number of stages. Increasing the number of stages increases the recovery. Any increased cost due to increasing the number of stages must equal the greater value of the increased recovery:

$$ds = dr \tag{4}$$

Multiplying Eq. (4) by (dR/dn) and rearranging, gives:

$$dR/dn = \frac{(ds/dn)}{(dr/dR)} \tag{5}$$

At optimum conditions:

$$\left(\frac{\partial R}{\partial n} \right)_E = \lim \frac{(\Delta s/\Delta n)}{(\Delta r/\Delta R)} \tag{6}$$

$$= \frac{\text{increase in cost with addition of } n}{\text{increase in value with increase in } R}$$

In the same way, the optimum with respect to E:

$$\left(\frac{\partial R}{\partial E} \right)_n = \lim \frac{(\Delta t/\Delta E)}{(\Delta r/\Delta R)} \tag{7}$$

$$= \frac{\text{increase in cost with increase in } E}{\text{increase in value with increase in } R}$$

You can calculate the optimum values of n and E from Eq. (2) and (3) after determining optimum $(\partial R/\partial n)$ and $(\partial R/\partial E)$ from Eq. (6) and (7) given above.

However, it's more convenient to use the chart given in this article. Here, n and E are shown as a function of $(\partial R/\partial n)$ and $(\partial R/\partial E)$. Number of stages, extraction factor and recovery are read directly from this chart at the intersection of optimum $(\partial R/\partial n)$ and $(\partial R/\partial E)$.

This procedure is an incremental investment-return

Data for Example 1: Countercurrent Decantation

E	I, \$	ΔI, \$	Invest., \$/Day, $\left(\frac{\Delta I \times 0.4}{365}\right)$	Entrain., \$/Day	Total Cost, \$/Day, $(\Delta t/\Delta E)$	$(\partial R/\partial E)$, $\frac{(\Delta t/\Delta E)}{(\Delta r/\Delta R)}$	E
2	461,000						
		127,000	139	8	147	0.00367	2.5
3	588,000						
		112,000	123	8	131	0.00327	3.5
4	700,000						
		96,000	105	8	113	0.00282	4.5
5	796,000						
		87,000	95	8	103	0.00258	5.5
6	883,000						

method. Optimum design is set so the last increment of investment yields a specified return.

The usual elements of cost make up the factors $(\Delta s/\Delta n)$, $(\Delta t/\Delta E)$ and $(\Delta r/\Delta R)$. These in turn determine $(\partial R/\partial n)$ and $(\partial R/\partial E)$. You must examine each case to determine how much each element contributes.

This method uses changes in costs as E and n change, rather than absolute costs; a great simplification because many costs don't change very much with changes in E and n.

What's the Range of the Chart

Although the chart is designed for linear distributions, you can use it, with some accuracy, on systems that are only moderately linear—if the number of stages is small. In these cases, use an average distribution coefficient. Verify the accuracy by comparing recovery predicted from the chart with that calculated from an operating diagram.

Using Eq. (1) for solvent extraction and absorption is well recognized,[5, 6] and similar equations for countercurrent decantations have been proposed.[7, 8, 9]

In countercurrent decantation, the concentration of solute in the underflow and overflow solutions are equal and the distribution coefficient m is therefore equal to 1. If the amount of solution in the feed pulp and underflow slurry are equal, then the ratio of wash liquor (or overflow) to underflow solution is equal to B/A. This becomes the extraction factor E.

Actually, the feed and underflow pulps don't often have the same solution content. Cahalan[9] calculated such cases and found the difference doesn't affect the optimum design point determined with this method (except in extreme cases).

For example: In a three-stage system with an extraction factor of 1.5, the ratio of feed to underflow was varied from 0.63 to 1.25. Optimum point shifted less than 10%.

Meet Your Author

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Example 1: Countercurrent Decantation

You want to design a system to recover uranium from a leach pulp containing 60% solids by countercurrent decantation with wash water. Plant capacity is 1,000 tons of solids/day with soluble uranium content of 5 lb./ton of solids.

Uranium in the number one overflow (pregnant) solution is worth \$8.00/lb. Thickener underflows are 60% solids and thickener design area is 4,000 sq. ft.

Soluble uranium treated in the plant at 100% recovery ($R = 1$) is worth:

$$\Delta r/\Delta R = (1{,}000 \times 5 \times 8)/1 = \$40{,}000/\text{day}$$

Capital investment per thickener, including auxiliaries and installation, is estimated at \$75,000. We'll take the cost of capital, for this example, at 40%/year (30% return plus 10% depreciation).

Cost/stage-day then becomes:

$$(75{,}000 \times 0.4)/365 = \$82.30/\text{stage-day}$$

Except for the cost of additional flocculating agent, we'll assume operating costs for each added stage are negligible. Flocculant requirements are 0.02 lb./ton at a cost of \$1.00/lb. Flocculant requirements are:

$$1{,}000 \times 0.02 \times 1.00 = \$20.00/\text{stage-day}$$

Total cost for each added stage is:

$$\Delta s/\Delta n = (20.00 + 82.30)/1 = \$102.30/\text{day}$$

And, for optimum conditions:

$$\partial R/\partial n = 102.30/40{,}000 = 0.00255$$

Number one overflow (pregnant) solution B is processed by solvent extraction; cost of this depends on

Data for Example 2: Solvent Extraction

E	B, Gpm.	I, $	ΔI, $	Invest, $/Day, $(\Delta I/\Delta E)$	$(\partial R/\partial E)$, $\frac{(\Delta t/\Delta E)}{(\Delta r/\Delta R)}$	E
2	60	46,640				
			12,840	14.08	0.0174	2.5
3	90	59,480				
			11,240	12.33	0.0152	3.5
4	120	70,720				
			10,120	11.09	0.0137	4.5
5	150	80,840				
			9,360	10.14	0.0125	5.5
6	180	90,200				

the size of the stream processed. Plant investment for this portion of the plant is estimated as:

$$I = \$18{,}000(B, \text{gpm.})^{0.6}$$

Operating costs, other than solvent loss, are assumed independent of B. Entrained solvent losses are 0.02% of the volume of B. Solvent cost is $0.25/gal. Volume of solution in the underflow A, at a density of 1.0, is:

A = 1,000 ton solids/day × ton pulp/0.6 ton solid × 0.4 ton solution/ton pulp × 2,000 lb./ton × day/1,440 min. × gal./8.34 lb.

A = 111 gpm.

Since $E = (mB/A)$, and $m = 1$, number one overflow B = 111 gpm./unit extraction factor E.

Cost of entrainment is then:

$$111 \times 60 \times 24 \times 0.0002 \times 0.25 = \$7.98/\text{day-}E$$

Cost of extraction factor E, in terms of investment cost (40%/year) and entrainment loss, as well as optimum $(\partial R/\partial E)$ are calculated and shown in Table 1.

From these values, we've plotted $(\partial R/\partial E)$ as a function of E on the chart as line L. Optimum $(\partial r/\partial n)$ is also plotted and the intersection of the two lines gives you the optimum economic design as 5.1 theoretical stages at an extraction factor of 3.1. Recovery is 99.7%.

From this:

$$B = 111 \times 3.1 = 344 \text{ gpm.}$$

Example 2: Solvent Extraction

You want to recover vanadium by solvent extraction from a 300-gpm. by-product stream containing 1.0-gm. V_2O_5/liter. Solvent cost is $0.25/gal. and the distribution coefficient m between the solvent and solution is 10. Feed solvent contains 1.0-gm. V_2O_5/liter because of incomplete stripping. Value of vanadium in the extract is $0.25/lb. of V_2O_5 (value of product minus cost of process from extract to product).

Recoverable vanadium is:

$$\frac{x_F - (y_F/m)}{x_F} = \frac{1.0 - (1.0/10)}{1.0} = 0.90 \text{ or } 90\%$$

Plant stream contains:

$$300 \times 1.0 \times 0.00834 \times 60 \times 24 = 3{,}600 \text{ lb. } V_2O_5/\text{day}$$

Of this, 90% is recoverable:

$$3{,}600 \times 0.90 = 3{,}240 \text{ lb. } V_2O_5/\text{day}$$

With an increase in recovery the increase in value will be:

$$\Delta r/\Delta R = (3{,}240 \times 0.25)/1 = \$810/\text{day}$$

Installed cost/stage for the extraction plant is estimated at $28,000 and this is independent of the solvent feed rate B. Any increase in operating costs with an increase in number of stages is assumed negligible. Taking the cost of invested capital at 40%/year, the cost of each added stage is:

$$\Delta s/\Delta n = (28{,}000 \times 0.40)/365 = \$30.70/\text{day}$$

And, at optimum conditions:

$$\partial R/\partial n = 30.70/810 = 0.0379$$

Operating costs of the stripping step, where the solute is removed from the extract, are assumed independent of the feed rate B. However, plant investment cost for this stripping operation is a function of the feed rate B. It's estimated as:

$$I = 4{,}000(B, \text{gpm.})^{0.6}$$

Investment costs as a function of E are shown in Table 2 along with optimum values of $(\partial R/\partial E)$.

Optimum values of $(\partial R/\partial E)$ as a function of E are plotted on the chart as line M as well as the optimum value of $(\partial R/\partial n)$. Design conditions that give the optimum economic points are found at the intersection of these two lines and are: 2.4 theoretical stages with an extraction factor of 3.9. Solvent feed is:

$$B = (3.9 \times 300)/10 = 117 \text{ gpm.}$$

Recovery of vanadium is 0.98. This corresponds to an 87% over-all recovery since 90% is the maximum recoverable.

Both examples shown contain several simplifying assumptions; but you can easily handle more complex problems by this same method. In some cases a series of approximations is necessary.

REFERENCES

1. Tiller, F. M., and R. S. Tour, *Trans. AIChE*, **40**, 317-332 (1944).
2. Scheibel, E. J., *Chem. Eng.*, Nov. 1957, pp. 238-240.
3. Kremser, A., *Nat. Pet. News*, May 21, 1930, p. 42.
4. Souders, M., and G. G. Brown, *Ind. Eng. Chem.*, **24**, 519 (1932).
5. Sherwood, T. K., and R. L. Pigford, "Absorption and Extraction," (2nd Ed.), McGraw-Hill Book Co., Inc., New York, 1952.
6. Treybal, R. E., "Liquid Extraction," McGraw-Hill Book Co., Inc., New York, 1951.
7. Sanders, M. T., *Chem. Met. Eng.*, March 1932, p. 161.
8. Mastin, M. G., *Chem. Eng*, Jan. 1950, p. 100.
9. Cahalan, M. J., *Mining Mag.*, April 1957, p. 201.

Since experimental measurements are necessary . . .

- Where do we get rate coefficients?
- When and how do we use experimental values?
- What are the limitations of these rate coefficients?

Correlate Mass Transfer Coefficients

JAMES O. OSBURN, State University of Iowa, Iowa City, Ia.*

IN PREVIOUS articles, we have reviewed methods of making mass transfer calculations. Now suppose that we're ready to do a design calculation for an absorber. The next question is: What shall we use for our rate coefficients?

This article covers mass transfer coefficients and transfer units; the next of three covers stage efficiency and in the third, we'll show how the analogy between heat transfer and mass transfer is used in predicting mass transfer rates.

Experimentation Is Still the Rule

The size of mass transfer coefficients depends on three basic factors:

- Kind of equipment used and its design.
- Flow rates of the two phases.
- Physical properties of the fluids.

There have been many articles published which contain data and correlations of mass transfer coefficients. As enough information becomes available, some day we may be able to calculate the coefficient for any desired combination of the three factors. However, we haven't reached this state yet. Where a lot depends on our answer, some experimental measurements must still be made.

At best, we must have some data on the performance of the kind of equipment we are going to use. With caution, we may be justified in extrapolating to other flow rates and to fluids other than those used in the experiments. If we may do this, we may be able to get enough information from the literature to proceed with the design.

However, there are a number of factors which may cause errors if we try to avoid actual measurements.

If we calculate a rate coefficient and use it for design, there are two basic factors which may cause our design to fail.

- Deviations due to equipment.
- Deviations due to substances being treated.

When there are complicating factors due to either of these causes, we may expect that the actual coefficients obtained will be quite different from those we calculate from correlations.

What Factors To Watch in Equipment

In an experimental program for measuring mass transfer coefficients in packed towers, special precautions are taken to make sure that the packing is wet and that there is no channeling. This may not be done in full-scale equipment. Even in experimental equipment, the coefficients depend on the roughness of the tower wall because of the tendency for liquid to flow along the wall rather than over the packing.

There are end effects which are often neglected. This can lead to serious error, especially in spray columns where most of the mass transfer takes place immediately after the drops of dispersed fluid are formed.

Packing which is supposedly the same as the standard may give different coefficients because of differences in arrangement. In some installations, packing is stacked in a regular arrangement; while in others it is dumped in a random fashion. The rate of transfer will be different, depending on the manner of dumping, whether the tower is empty or full of liquid or whether shaking is used.

Change in System Causes Unexpected Effects

Correlations of mass transfer coefficients depend on the effect of the gross properties of the substances involved. In many cases the coefficient changes in a simple manner for changes in the diffusivity, viscosity and density. Sometimes, however, there are effects which are not anticipated. These are caused by an almost undetectable change in the physical properties of the fluid. Often, these effects make a very great change in the rate of mass transfer.

Some examples of these changes in physical properties are well-known, others are just coming to light. The attempt to absorb sulfur trioxide in water fails because of the reaction between the sulfur trioxide and the vapor above the liquid water. The resulting fine fog of sulfur trioxide is not easily condensed.

* To meet your author see *Chem. Eng.*, Mar. 24, 1958, p. 169.

The rate of absorption of SiF_4 is slower than would be expected because a film of solid silica forms in the liquid and inhibits further absorption. [Whyness, *Trans. Inst. Chem. Engr.*, 34, 12-17, London (1956)].

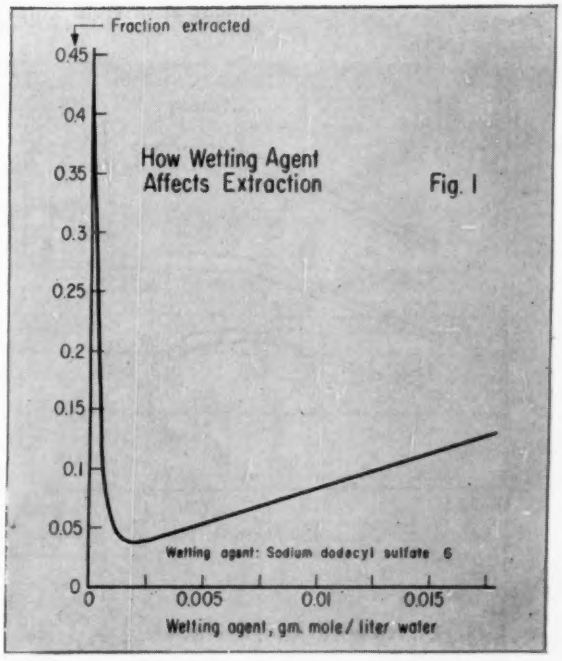
The inhibiting effect of surface-active molecules in absorption, extraction and evaporation is well recognized. In extraction, the presence of as little as 0.001 mole per liter of a wetting agent reduces the rate of extraction by a factor of ten. In Fig. 1, we show a typical case [Garner and Skelland, *Ind. Eng. Chem.*, 48, 51 (1956)].

The presence of impurities in ordinary water and impurities dissolved from plastic tubing has been found to change both the equilibrium and the rate of extraction for some systems. Certain substances such as alcohols destroy this inhibiting effect.

We may conclude that it sometimes isn't good enough to measure rate coefficients experimentally unless the materials we use have the same impurities that will be found in full scale operation.

After the warning of putting too much confidence in correlating transfer coefficients, we can now show that correlations of mass transfer coefficients do have some value. They can be used to calculate a coefficient for preliminary design. Also, they can serve as a guide and a comparison when measuring coefficients experimentally.

Therefore, let's explore some of the data on mass transfer coefficients to point out unifying features.



Films and Area Control Rates

For design, over-all coefficients $K_g a$ or over-all height of transfer units H_{og} are most useful. If we neglect a resistance at the interface, we find that these qualities depend on three independent factors: the resistance of the two fluid films and the interfacial area per unit volume.

We have to predict the effect on each of these factors. Then combine them into an over-all coefficient by an equation such as the following which applies to gas absorption.

$$\frac{1}{K_g a} = \frac{1}{k_g a} + \frac{H}{k_l a} \qquad (1)$$

In terms of transfer units, Eq. (1) becomes:

$$H_{og} = H_g + mGH_l/L \qquad (2)$$

Film resistances depend on the diffusive properties of the solute in the phases which are present and on factors such as turbulence which reduce the film thickness. In the remainder of this article, we'll examine how the film coefficients and interfacial area vary with conditions in some types of mass transfer equipment.

When To Use Wetted-Wall Columns

Although not of industrial importance, the wetted-wall column is a favorite experimental device because the interfacial area is measurable. For mass transfer from a liquid to a gas, the effect of the liquid film coefficient is eliminated by using pure liquids and measuring the vaporization rates.

For turbulent flow, the gas-film coefficient for wetted-wall towers can be correlated by Eq. (3) [T. K. Sherwood and R. L. Pigford, "Absorption and Extraction," 2nd. Ed., p. 77, McGraw-Hill Book Co. (1952)].

$$k_g = 0.023 Re^{0.83} \left(\frac{\mu}{\rho D_v}\right)^{0.44} \left(\frac{P}{p_{bm}}\right) \left(\frac{D_v}{dRT}\right) \qquad (3)$$

From Eq. (3), we may conclude that the gas-film coefficient varies with the 0.83 power of the gas velocity G; inversely as the 0.17 power of the tube diameter d; directly as the 0.56 power of the diffusion coefficient D_v at constant temperatures; directly with the 0.44 power of the pressure because of its effect on the density ρ. The ratio P/p_{bm} will not change very much as the pressure changes.

The effect of temperature is obscured by its effect on the diffusion coefficient and density. Diffusion coefficient D_v varies with the 1.5 power of the temperature. Hence, the over-all effect is that k_g varies directly with the 0.28 power of the temperature at constant mass velocity.

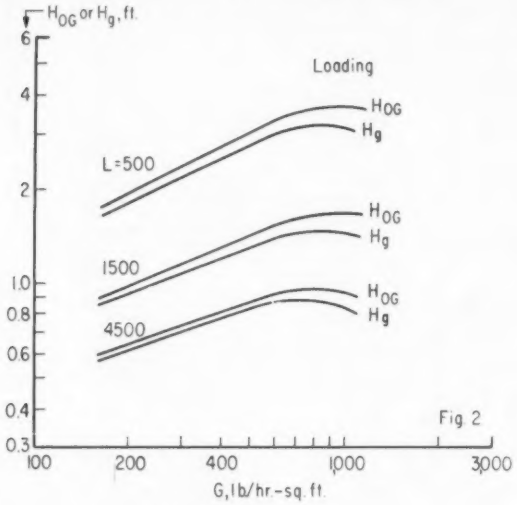
Consider Packed Column Behavior

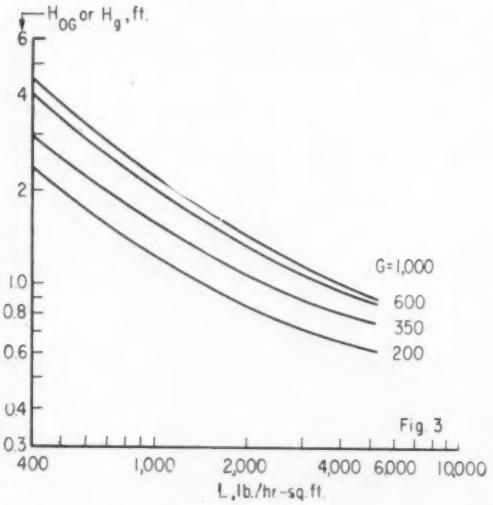
Gas-film coefficients in packed columns act much the same as in wetted-wall towers, except for the effects of the packing and the liquid flow over it.

We show typical plots of H_g vs. gas rate for the absorption of ammonia in water in Figs. 2 and 3. [Sherwood and Pigford, previous reference, p. 282]. Typical values for a variety of packings are also available in J. H. Perry, "Chemical Engineers' Handbook," 3rd Ed., McGraw-Hill Book Co. New York (1950) and Max Leva, "Tower Packings and Packed Tower Design," U. S. Stoneware Co., Akron (1950).

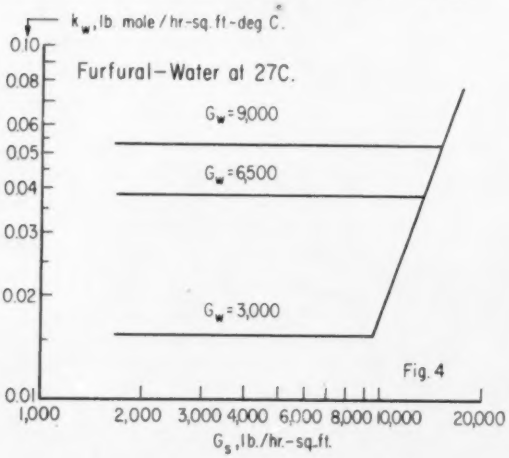
Slope of the curve at low velocities is different for different water rates but is in the neighborhood of 0.3

How Transfer Unit Height Changes With Fluid Rates





Extraction Coefficient Stable Over Flow Range



to 0.5. Since $H_g = G_m / (k_g a)\ (P)$, the $k_g a$ corresponding to these data vary only with the 0.7 to 0.5 power of the gas velocity; compared to 0.8 power for the wetted-wall towers. Near the loading point, the height of a transfer unit falls but operation may be unstable.

Other factors which affect H_g are:

- Liquid rate, H_g varies as $L^{-0.3}$
- Different gases, H_g varies as $(\mu/\rho D_v)^{0.5}$
- Different sizes of packing, H_g varies inversely as the surface area of the packing per unit volume.

How To Use the Correlations

These correlations are approximate. Also, there is not complete agreement between different investigators. However, if we keep this in mind we can do a fair job of estimating how a coefficient varies for moderate changes in conditions or for different substances. If we combine the information given above, we get this equation:

$$H_g = \frac{CG^{0.4}}{A^{0.5}L^{0.3}} \left(\frac{\mu}{\rho D_v}\right)^{0.5} \qquad (4)$$

The constant C depends on the packing. Use of this correlation is shown by the following examples.

Example 1—For the absorption of ammonia from air into water, $H_g = 1.3$ for $G = 500$ lb./sq.ft.-hr. and $L = 1{,}500$ lb./sq.ft.-hr. Calculate H_g for operation at $G = 1{,}000$ and $L = 500$.

$$H_g = 1.3\left(\frac{1{,}000}{500}\right)^{0.4}\left(\frac{1{,}500}{500}\right)^{0.3} = 2.4$$

Experimental value for $H_g = 2.8$

Example 2—From the data of Example 1, caluculate H_g for the absorption of oxygen from air into water when $G = 500$ and $L = 1{,}500$.

For ammmonia, $\mu/\rho D = 0.61$ and for oxygen, $\mu/\rho D = 0.74$. Hence, $H_g = 1.3(0.74/0.61)^{0.5} = 1.4$. Most of the resistance in oxygen absorption is in the liquid film. This calculated value of H_g is satisfactory for correcting over-all values to find H_l.

Example 3—The data in Example 1 are for 1½-in. Raschig rings. Calculate H_g for ½-in. Raschig rings.

For 1½-in. rings, area per cu. ft. = 36 sq. ft. and for ½-in. rings, area per cu. ft. = 114 sq. ft. Hence, $H_g = 1.3(36/114)^{0.5} = 0.73$. Experimental value is 0.80.

For Liquid Film in Packed Columns

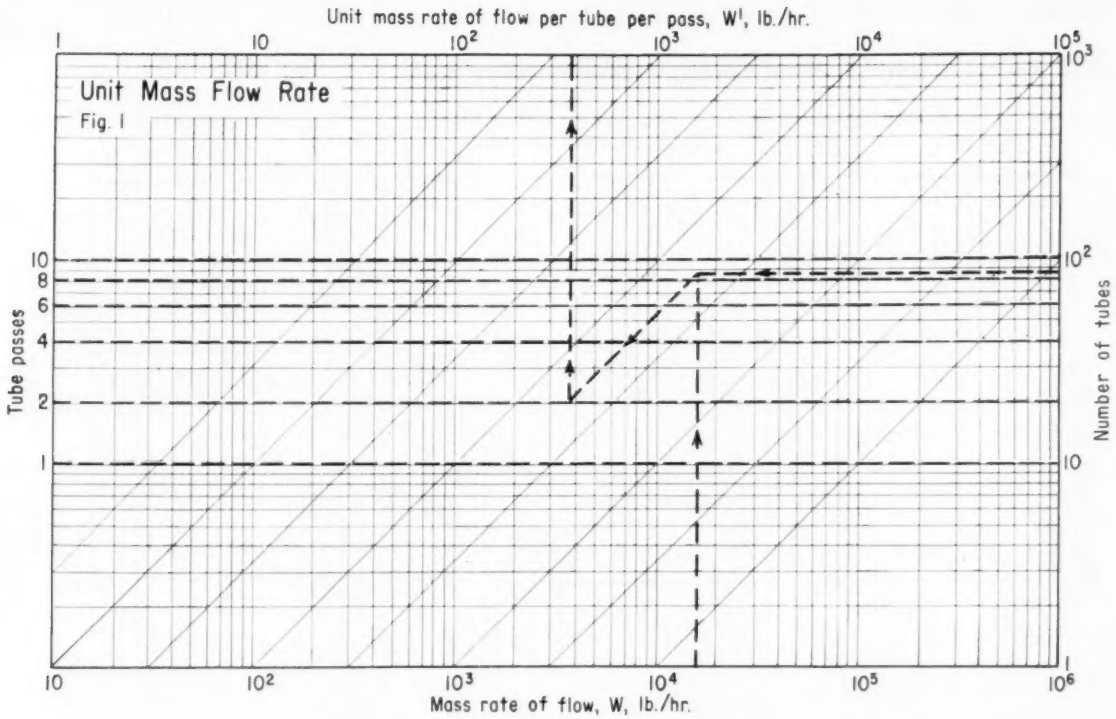
Leva (previous reference) gives this equation for liquid films in absorption:

$$H_l = \frac{1}{a'}\left(\frac{L}{\mu'}\right)^{n}\left(\frac{\mu'}{\rho' D'}\right)^{-0.5} \qquad (5)$$

Here, D', μ' and ρ' are liquid diffusion coefficient, viscosity and density respectively. The values of a' and n depend on the type of packing used. Values for several types of packing are given by Leva and others can be calculated from experimental data.

Recent experiments [Murphy, Lastovica and Skrzec, *AIChE Journal*, 2, 451 (1956)] with a horizontal extraction column, where the area can be measured, show that the water-film extraction coefficient k_w is a function of G_w, $\sigma^{0.07}$, $\rho^{1.46}$, $\mu_w^{-1.0}$ and $D_v^{1.0}$. It is independent of G, up to a point; then increases rapidly as shown in Fig. 4.

Many more data must be collected and correlated before we can predict the effect of different systems on the extraction rates.



Speed Heat Exchanger Computations

Use these new charts to find tubeside heat transfer coefficients and pressure drops in the tubes only when streamline flow occurs.

NING HSING CHEN, Heat Transfer Div., M. W. Kellogg, Jersey City, N. J.*

By using these new charts, we can rapidly evaluate tubeside heat transfer coefficients and pressure drops through the tubes of tubular heat exchangers during streamline flow. For methods showing the corresponding quantities for turbulent flow, see *Chem. Eng.*, June 30, 1958, p. 110 and Sept. 22, 1958, p. 160.

Find Tubeside Heat Transfer Coefficient

Find the heat transfer coefficient on the tubeside for a fluid flowing through a 1-2 exchanger at a rate of 16,000 lb./hr. The fluid is heated in two passes from 95 to 145 F. inside 86 tubes each 1-in. O.D. × 14 BWG and 12 ft. long. At the average temperature of 110 F., the fluid shows the following properties: viscosity Z is 4.8 centipoises, thermal conductivity K is 0.0775 Btu./hr.-sq.ft.-deg.F./ft. and specific heat C is 0.485 Btu./hr.-deg. F.

Step 1—First, obtain from Fig. 1 the unit mass rate of flow per pass per tube. Erect a line perpendicularly through W of the 16,000 lb./hr. to meet the line drawn horizontally from 86 which is the number of tubes. Through this intersection draw a line at 45° to meet the number of tube passes line of 2. Through the last intersection draw a line perpendicularly to the rate of flow per tube per pass. Read the value of W' as 370.

Step 2—Check the Reynolds number from Fig. 2 to determine if streamline flow occurs. Reynolds number must be less than 2,100. Erect a line perpendicularly through W' of 370 to meet the line drawn horizontally from inside tube diameter of 0.834 in.

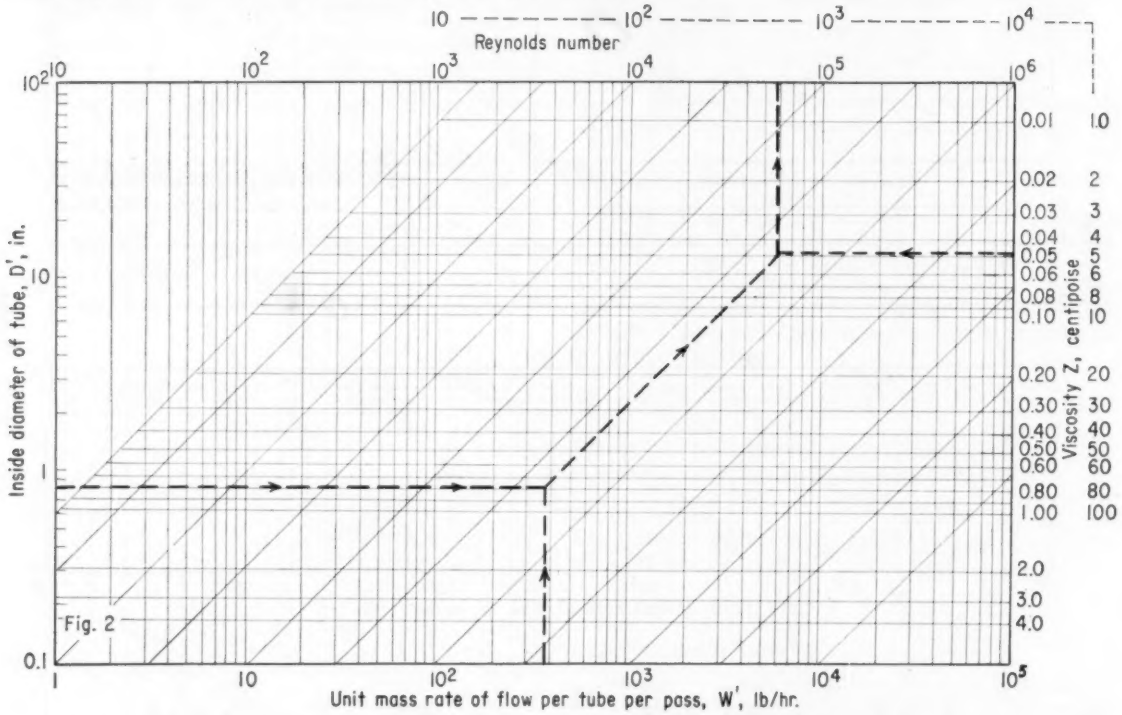
Through this intersection, draw a line at 45° to meet the line drawn horizontally from viscosity Z of 4.8. Then through the last intersection, draw a line vertically to the Reynolds number which is 590. Note that viscosity-Reynolds number coordinates must correspond.

Step 3—Finally, find the heat transfer coefficient from Fig. 3. Erect a line through W' of 370 to meet the specific heat line C equal to 0.485. Then move horizontally to meet thermal conductivity line K equal to 0.0775.

The abscissa of this point found at the top of the chart is the heat transfer coefficient h corrected for viscosity and is equal to 16.0. Correct this value for tube length and for tube size. Correction factor for 12-ft. tube length is 1.10 and for tube size is 0.744.

* To meet your author, see *Chem. Eng.*, June 30, 1958, p. 140.

Find Reynolds Number From Corresponding Viscosity Scale



Hence, corrected heat transfer coefficient $h = 16.0 \times 1.10 \times 0.744 = 13.1$ Btu./hr.-sq.ft.-deg. F.

Here are the equations used for correlating the variables and constructing the charts. The Sieder and Tate equation[8] for streamline flow is:

$$\frac{hD}{k} = 1.86\left[\left(\frac{DG}{\mu}\right)\left(\frac{C\mu}{k}\right)\left(\frac{D}{L}\right)\right]^{1/3}\left(\frac{\mu}{\mu_w}\right)^{0.14} \quad (1)$$

However, before we can use Eq. (1) to find heat transfer coefficients, we must first determine whether streamline flow takes place in the tubes. Hence, we convert the usual form of Reynolds number DG/μ into the following form:

$$Re = 6.31W'/D'Z \quad (2)$$

From Eq. (2) we construct Fig. 2 which enables us to read Reynolds number directly. In Eq. (2), W' is the mass rate of flow per pass per tube in lb./hr. and is correlated to the mass rate of flow in lb./hr., the number of passes and the number of tubes as:

$$W' = WP/N_T \quad (3)$$

We use Eq. (3) to construct Fig. 1 from which we obtain the value of W' directly.

In common engineering units, we can express Eq. (1) as:

$$h\left(\frac{Z}{Z_w}\right)^{-0.14} = 24.2\left(\frac{1}{D'}\right)\left(\frac{W'}{L}\right)^{1/3} C^{1/3}k^{2/3} \quad (4)$$

To construct Fig. 3, we use Eq. (4).

Nomenclature

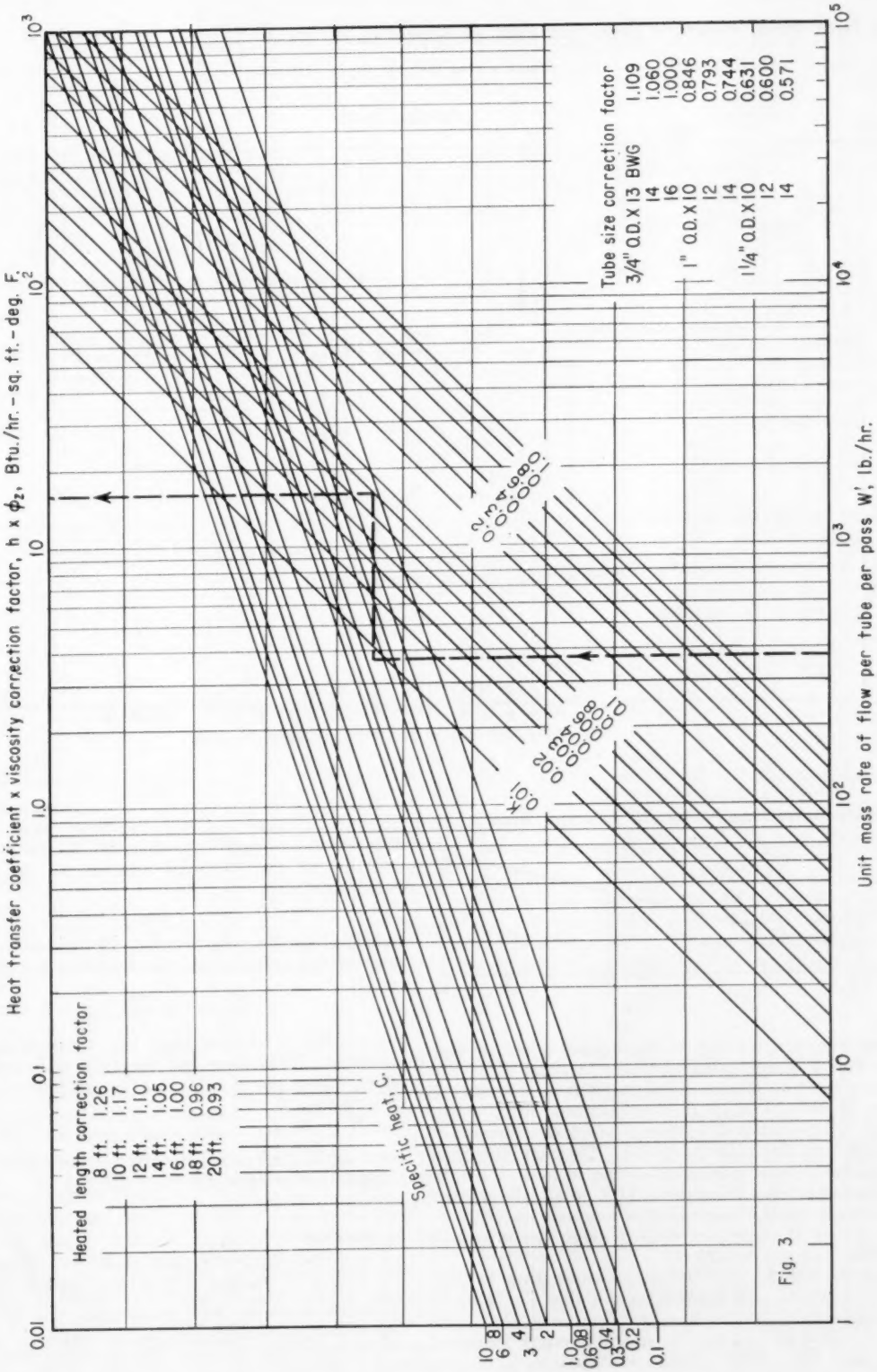
C	Specific heat, Btu./lb.-deg. F.
D	Inside tube diameter, ft.
D'	Inside tube diameter, in.
f	Friction factor.
g	Gravitational constant, 32.2 ft./sec.^{2}
G	Mass velocity inside tube, lb./hr.-sq.ft.
G'	Mass velocity inside tube, lb./sec.-sq.ft.
h	Heat transfer coefficient, Btu./hr.-sq.ft.-deg. F.
K	Thermal conductivity, Btu./hr.-sq.ft.-deg. F.-ft.
L	Tube length or length of travel, ft.
N_T	Number of tubes.
P	Number of tube passes.
$S.G.$	Specific gravity.
W	Mass rate of flow, lb./hr.
W'	Unit mass rate of flow per tube per pass, lb./hr.
Z	Viscosity at average fluid temperature, centipoise.
Z_w	Viscosity at tube wall temperature, centipoise.
ΔP	Pressure drop, lb./sq.ft.
$\Delta P'$	Pressure drop, psi.
μ	Viscosity at average fluid temperature, lb./hr.-ft.
μ_w	Viscosity at tube wall temperature, lb./hr.-ft.
ρ	Density, lb./cu. ft.

How To Find Pressure Drop

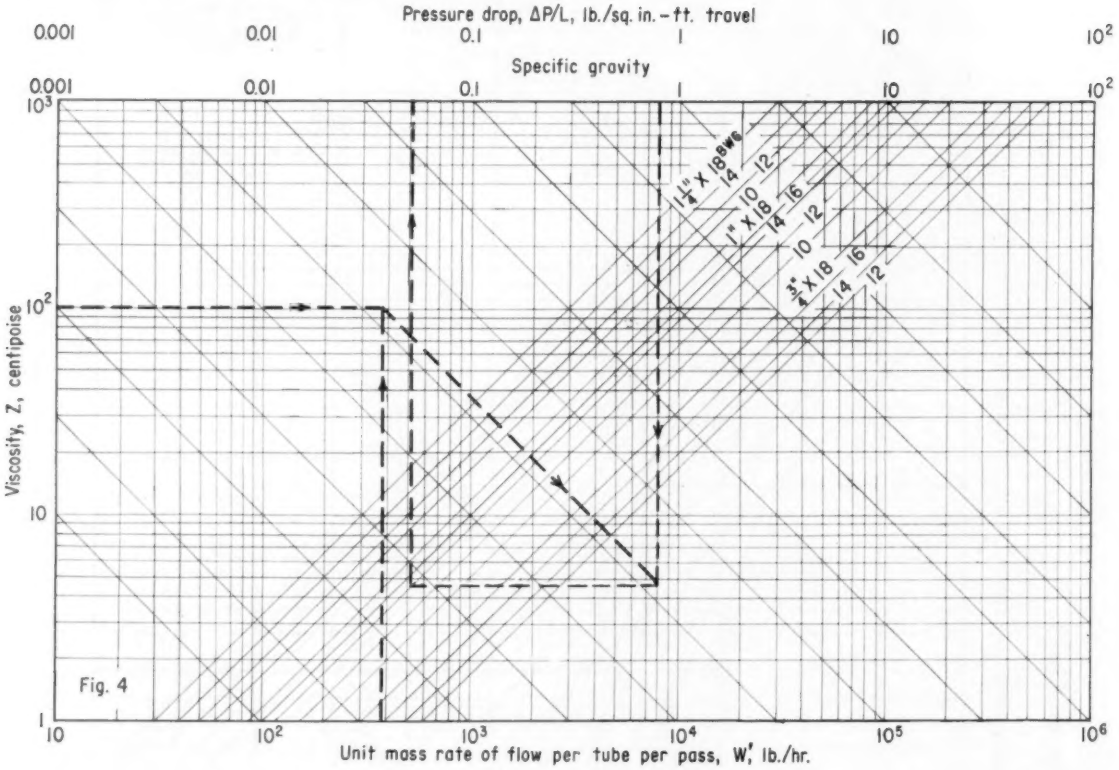
Find the pressure drop through the tubes for a fluid flowing through a 1-2 exchanger at a rate of 16,000 lb./hr. Fluid is heated in two passes inside 86 tubes each 1-in. O.D. × 14 BWG and 12 ft. long. Properties of the fluid at the average temperature are: viscosity $Z = 100$ centipoises and specific gravity is 0.8. Viscosity at the wall temperature is 50 centipoises.

Step 1—Find the unit mass rate of flow from Fig. 1. Here, W′ equals 370 lb./hr. per tube per pass.

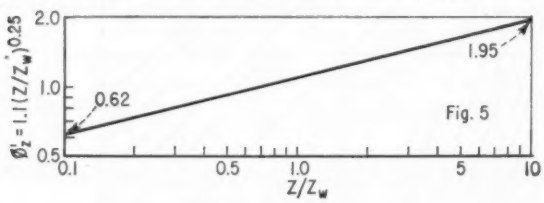
Read Heat Transfer Coefficient From Scale at Top of Chart



Find Isothermal Pressure Drop per Foot of Travel



Viscosity Correction Factor for Pressure Drop



Step 2—Next, we find the isothermal pressure drop from Fig. 4. Erect a line vertically through $W' = 370$ to meet the line drawn horizontally from viscosity Z which is 100. Through this intersection, draw a line at 45° to meet the line drawn vertically downward through specific gravity of 0.8. Through this last intersection, draw a horizontal line to meet the tube size line which for this case is 1-in. × 14 BWG. Read the abscissa of this point on the top scale as $\Delta P'/L = 0.052$. Then the pressure drop through the tube only is $0.052 \times 12 \times 2 = 1.25$ psi.

Step 3—Finally, find actual pressure drop by correcting for tube wall temperature. Using Fig. 5 $\phi_z' = 1.32$ when $Z/Z_w = 100/50 = 2$. Therefore, the actual $\Delta P' = 1.25/1.32 = 0.95$. If we use a safety factor of 1.25, then $\Delta P' = 0.95 \times 1.25 = 1.20$ psi.

To calculate the pressure drop, we can use the Fanning equation[7] which is

$$\Delta P = 2fL(G')^2/gD \quad (5)$$

For streamline flow, the friction factor is a linear function of the Reynolds number as the following equation shows.

$$f = 16\mu/DG \quad (6)$$

Substituting Eq. (6) into Eq. (5) and converting to engineering units, we get the following equation:

$$\frac{\Delta P'}{L} = \frac{5.46ZW'}{10^7(D')^4(S.G.)} \quad (7)$$

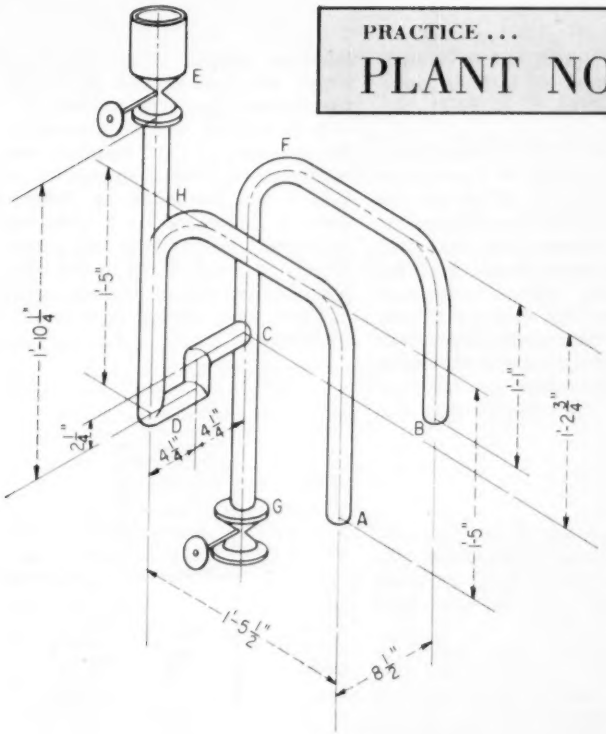
We use Eq. (7) to construct Fig. 4 assuming isothermal flow. To account for the tube wall temperature effect, divide the result $\Delta P'/L$ by the following correction factor:

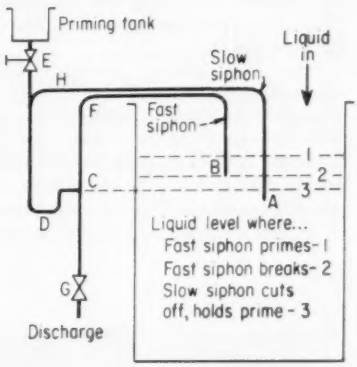
$$\phi_z' = 1.1(Z/Z_w)^{0.25} \quad (8)$$

Here ϕ_z' is the viscosity correction factor for streamline pressure drop and is shown in Fig. 5.

REFERENCES

1. D. A. Donohue, *Pet. Refinery*, **34**, No. 10, 132 (1955).
2. D. A. Donohue, *Pet. Refiner*, **34**, No. 11, 176 (1955).
3. D. Q. Kern, "Process Heat Transfer," p 834, McGraw-Hill Book Co., New York (1950).
4. W. H. McAdams, "Heat Transmission," 3rd Ed. McGraw-Hill Book Co., New York (1954).
5. L. F. Moody, *Trans. ASME*, **66**, 671 (1944).
6. W. L. Nelson, "Petroleum Refinery Engineering," 3rd. Ed., p. 497, McGraw-Hill Book Co., New York (1949).
7. J. H. Perry, "Chemical Engineers' Handbook," 3rd. Ed., McGraw-Hill Book Co., New York (1950).
8. E. N. Sieder and G. E. Tate, *Ind. Eng. Chem.*, **28**, 1429-35 (1936).





Always-ready siphon makes a convenient way of controlling tank level in cases where underliquid connections are difficult or impossible to make.

Tank Siphon Never Loses Prime

★ **Winner of the July Contest by**

C. F. A. Roberts
Superintendent, Plant Investigations Dept., Orr's Zinc White Ltd. Imperial Smelting Corp. Ltd., Widnes, Lancs., England.

It is often necessary in chemical plant operations to have a means of maintaining liquid level in a tank between working limits. This usually presents no problem when new equipment is being installed, but may involve a difficult situation in modifying existing equipment, especially if glass- or rubber-lined.

The sketch at the left shows an ever-primed siphon which is easy to construct and suitable for existing tanks. The righthand sketch shows how the siphon rests on the tank and also shows the approximate levels between which it works.

After the tank has been filled the siphon is primed by filling through valve *E*, with valve *G* closed. Closing valve *E* and opening valve *G* then starts the siphon, as long as the tank level is above *B* (Level 2). Priming is easier if the siphon ends are plugged during filling. When the level drops to *B* the fast siphon *BFC* breaks and empties. For a short time, or until the level drops to *C* (Level 3), the slow siphon will continue a slow discharge through *AHDC*. When the level reaches *C* (Level 3), the slow siphon will cut off, but will hold its prime due to the liquid seal at *D*.

When further liquid is added to the tank and the level rises above Level 3, slow flow will resume through the slow siphon, the rate of flow increasing as the level continues to rise. At Level 1, a short way above *B*, the flow will have increased enough so that the liquid

NEXT ISSUE: Breather Vents HCl From Solvent Tanks
By C. W. Hamilton, Winner of the August Contest

★ How Readers Can Win

$50 Prize for a Good Idea—Until further notice the Editors of *Chemical Engineering* will award $50 each four weeks to the author of the best short article received during that period and accepted for Plant or Design Notebook.

Each period's winner will be announced in the second following issue and published in the third or fourth following issue.

$100 Annual Prize—At the end of each year the period winners will be rejudged and the year's best awarded an additional $100 prize.

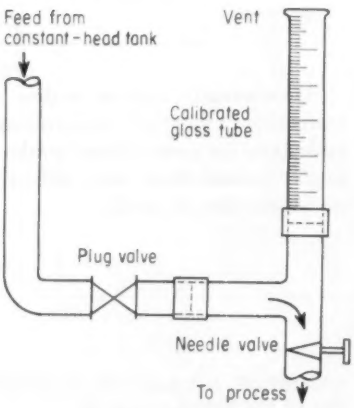
How to Enter Contest—Any reader (except a McGraw-Hill employee) may submit as many contest entries as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Acceptable non-winning articles will be published at space rates ($10 min.)

Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address Plant & Design Notebooks, *Chemical Engineering*, 330 W. 42nd St., New York 36, N. Y.

discharging at *C* into the riser *FG* will act like a laboratory water aspirator and will create enough vacuum to prime the fast siphon *AFC* rather suddenly. At this point the entire section *BFCG* will be full and rapid siphoning will resume. The cycle of operations thus starts all over again.

The dimensions shown have worked satisfactorily in practice, though considerable latitude is possible. However, I do not recommend a larger tubing diameter than 2 in., while dimension *EH* should be as short as possible. The lower that end *B* is, the sharper will be the cut-off action of the siphon, but the siphon will not work at all if *B* is lower than *D*.

(*Editor's Note*—Dr. Roberts sent a small glass model of the siphon with his manuscript. With the aid of some of his wife's cooking utensiles and the kitchen sink, the editor gave the siphon a thorough workout. It really works as stated. Watching the fast siphon suddenly pick up its prime as the level rises carried the editor back to one phase of his youth when he went in heavily for the black arts and legerdemain.)



Meter Without Orifice Handles Small Flows

C. M. Fair
Chemical Engineer, Plant Engineering, Appliance and T. V. Receiver Div. General Electric Co., Louisville, Ky.

Description of a simple flow meter using an orifice plate and glass standpipe for visual determination of the head (Bierbower, *CE*, Feb. 10, 1958, p. 152) recalls a similar device we once used, but without the orifice plate. In our case the restriction was a needle valve.

Our meter also took flow from a constant-head tank but varied the flow with the needle valve. We calibrated it by closing the plug valve and then, with a stopwatch, determined the volume per unit of time by drop in level in the glass tube.

The meter was simple and accurate, yet flexible owing to the possibility of instantaneous flow rate variation with the needle valve. One limitation lay in the fact that variation of level in the glass tube during measurement had to be small in comparison with the total head of the feed system.

The meter was also useful in measuring pumped feed flows to a process by connecting it into the suction side of the injecting pump. Here, the limitation described would not apply.

One great virtue of the meter as we operated it is that the fluid dynamics factors of specific gravity, viscosity, Reynolds number, temperature, etc., can be neglected. In calibrating it as described it is easy to make up a table to convert sec./unit volume to any desired flow units such as gpm. or lb./gal. or other units.

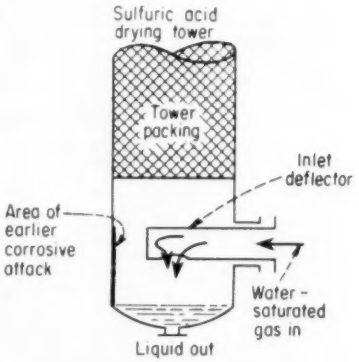
Teflon Caulking Prevents Leaks in Threaded Joints

Robert A. Snedeker
Photo Products Dept. E. I. du Pont de Nemours & Co., Parlin, N. J.

In medium pressure service screwed fittings often leak, even when the threads appear perfect and the joint is carefully made. The same thing happens even more frequently when stainless steel pipe and fittings are used. Sweating the joints with silver solder is effective in most cases, although to hold mercury or corrosive chemicals requires something other than silver solder.

An easy way to make an inert threaded joint is to caulk it with a thread of Teflon polytetrafluoroethylene plastic. The thread is simply wrapped around the female member and the joint assembled.

Such a joint will hold mercury, for example, at 1,500 psig. at room temperature. Small quantities of thread can be made by turning down a Teflon rod on a lathe and collecting the thread. The proper speed and depth of cut of the lathe, and the amount of thread needed for each joint, are easily discovered by trial and error.



Inlet Deflector Reduces Weak Acid Corrosion

Jerome A. Seiner*
Design Div., Chemical Corps Phosphate Dev. Works, Sheffield, Ala.

When using sulfuric acid to dry gases, both the temperature and the concentration affect the rate of corrosive attack on the tower wall. In normal operation of such a drying tower the momentum of the entering gases carries across from the inlet nozzle to the liquid film running down the opposite side. Hence, a disproportionate part of the moisture is taken out in this film.

The result is that there is a greater increase in temperature due to dilution and a greater decrease in concentration in the film than in the bulk of the acid, with accelerated corrosion in a relatively small area of the tower wall. A simple solution is to install an inlet deflector as in the sketch. This deflects the moisture-laden gas toward the large acid pool in the bottom where the effects of dilution are dissipated.

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Use Specific Gravity Like Molarity

C. L. Murray
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It is a little appreciated fact that specific gravities can be used like molarities in concentration calculations on solutions. Hence, many solutions can be made in the plant by the use of a simple hydrometer, without need for a laboratory analysis. But first, let's review the use of molarity.

The familar expression $(M_1)\ (V_1) = (M_2)\ (V_2)$ is fine if you want to dilute a given solution to something weaker. However, it is of no help if the problem is to increase the strength of the solution. The general expression:

$$(M_1)(V_1)+(M_2)(V_2)=(V_1+V_2)(M_3) \quad (1)$$

can be used either to increase or decrease the molarity of a given solution by adding a stronger or weaker stock solution. Here M_1 and V_1 refer to the molarity and volume of the present solution; M_2 and V_2 refer to the molarity and volume of the correcting solution; and M_3 refers to the desired molarity. In using the equation all factors except V_2 will be known and the equation can therefore be solved for that value.

For example, we have 1,000 liters of a solution having a molarity of 1.20 M in a given component. The desired solution is 1.25 M. The correcting solution has a molarity of 13.0 M. Then, using Eq. (1):

$$(1{,}000)(1.20)+(V_2)(13.0)=(1{,}000+V_2)(1.25)$$

and $V_2 = 4.26$ liters

Of course, if the strength of the correcting solution is much greater than the desired molarity, then the volume of correcting solution will be small compared to the main solution. If the two molarities are quite close together, then volume V_2 becomes appreciable.

In training chemical operators I always urge them to use the full formula, Eq. (1), in spite of any extra work involved, since it fits all situations and always gives the correct result.

When it comes to using specific gravity rather than molarity, we must subtract 1.000, the specific gravity of water, from all specific gravities before calculation. So, using the symbol sp. gr.* to mean (sp. gr. − 1) we have:

$$(V_1)(\text{sp. gr.}_1{}^*)+(V_2)(\text{sp. gr.}_2{}^*)=(V_1+V_2)(\text{sp. gr.}_3{}^*) \quad (2)$$

which is used exactly like Eq. (1).

Additions of stock solutions of known specific gravity, or of water, to single component solutions are easy with Eq. (2). In a multicomponent solution, one must resort to a molarity analysis of each component and then calculate the necessary corrections from Eq. (2).

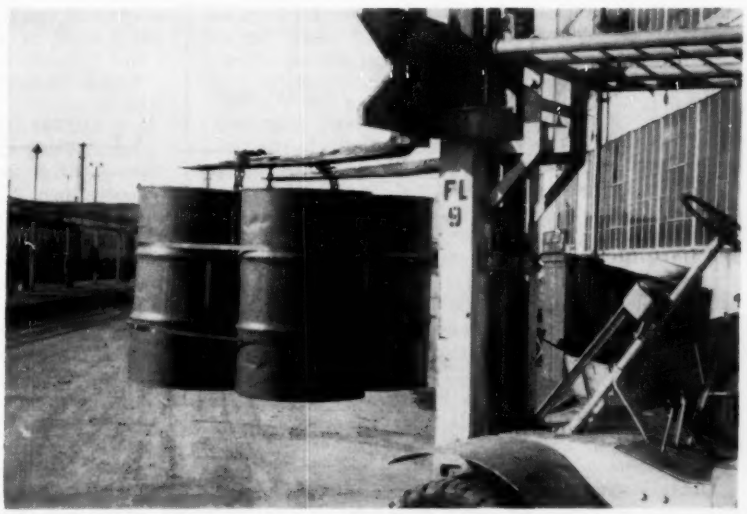
There are several short-cut variations of Eq. (2) which are very handy. For instance, in making a simple dilution the final volume of the solution is merely the ratio of the abbreviated specific gravities:

$$(V_1)(\text{sp.gr.}_1{}^*/\text{sp.gr.}_2{}^*)=\text{final volume} \quad (3)$$

And in increasing the specific gravity by evaporation, the reverse ratio holds true:

$$(V_1)(\text{sp.gr.}_2{}^*/\text{sp.gr.}_1{}^*)=\text{final volume} \quad (4)$$

Eqs. (3) and (4) apply equally well to either single- or multicomponent solutions.



Handling Drums Without Pallets

Western Pacific Railroad Co., San Francisco, has developed a money-saving method of handling 55-gal. drums without pallets, thus saving on pallet cost and avoiding the problem of pallet return.

As the photograph shows, the drums are steel-strapped together with a small amount of rough lumber dunnage so that four can be lifted and handled as a unit by means of a standard fork truck or crane.

The four drums are put together and separated into pairs by two pieces of lumber. One is placed between the swedges and the other between the bottom chine and the bottom swedge. Then the drums are bound with steel straps just above and below the swedges, as the illustration shows.

The upper piece of lumber serves as a lifting beam. A chain sling or a simple hook arrangement secured under the beam and over the truck forks does the trick. An alternate arrangement is to use a piece of I-beam across the top of the forks, with scrap-metal hooks, instead of the chain sling.

Western Pacific has been testing the method on shipments and has found it highly successful.

Electrical engineers, mostly, were the principals in this particular situation. However, this bipartisan report will be interesting reading for every engineer.

The Story of Engineers on Strike

What the Union Asked For

Engineers and Scientists of America
341 Munsey Building
Washington 4, D. C.

July 15, 1958

THE 1,800 professional engineers and scientists employed by the Radio Corporation of America at its Camden, N. J. area operations, who are represented by the Assn. of Professional Engineering Personnel—ESA, struck the RCA plants on Tuesday morning, July 8. The strike is still continuing. All 1,800 engineers and scientists involved in the strike are in the Research and Development Dept. at RCA.

Since the commencement of the strike, there have been a number of meetings between the parties held at the offices of Commissioner John Murray of the Federal Mediation Board. Thus far, however, the only change of position on the part of the parties is that APEP has reduced its salary increase demand from 19.5% to 10.5%. The company has offered a salary increase of 4%.

Other issues in the dispute relate to a merit program and a layoff and recall program.

APEP has asked for a guaranteed merit kitty of 5.7% of the engineering payroll/yr.; the merit kitty to be distributed in accordance with a merit rating program. This program takes into account such factors as: adequacy of technical knowledge; application of technical knowledge; evaluation of technical results; imagination and creativity; ability to meet project objectives; follow-through on assignments; breakdown of difficult assignments into manageable portions; clarity of communication of technical information; etc.

To date, the company has resisted this proposal. The company has offered a counter-proposal whereby it would set up a merit review plan by Nov. 1, 1958. Pilot studies of the plan would be made between Nov. 1958 and Feb. 1959, at which time the plan would be used to determine individual merit increases to be granted after that date. The plan would be established by the company. Its provisions would not be subject to collective bargaining. APEP has rejected the company's counter-proposal.

APEP has proposed that the layoff program, which is now almost completely discretionary on the part of the company, be revised and predicated on a

Information Released by the Company

Radio Corporation of America
30 Rockefeller Plaza
New York 20, N. Y.

July 8, 1958

MEMBERS of the Association of Professional Engineering Personnel, an independent union, today struck RCA facilities at Camden, Cherry Hill and Moorestown, N. J. Picket lines were established at employee entrances of the three locations.

The walkout, involving some 1,500 design and development engineers, began at 6 A.M. while a negotiating session was continuing at the Philadelphia office of Commissioner John Murray of the Federal Mediation and Conciliation Service.

Picketing was peaceful and the 15,000 RCA employees in the Camden area not members of the striking union reported for work this morning with no delay. Several hundred engineers who are members of the striking union also reported to work.

The company has offered a substantial general salary increase plus improvements in insurance and retirement plans and other contract benefits.

An RCA spokesman said that the principal issue discussed today was a proposed revision of the merit increase review program, with the union demanding a guaranteed fund for merit increase expenditures. The company offered a liberalized merit increase program.

The RCA spokesman said considerable progress was made during the all-night negotiations, with the union's demand for a guaranteed merit increase fund the major remaining issue.

Negotiation sessions were recessed at noon after 26 hours with plans for RCA and union representatives to meet again at Commissioner Murray's office tomorrow at 9 A.M.

July 9, 1958

The Association of Professional Engineering Personnel today postponed a meeting with Radio Corporation of America representatives at the Philadelphia office of Commissioner Murray, Federal Mediation and Conciliation Service.

An RCA spokesman said that APEP's postponement of the meeting came two hours before it was scheduled to start. Commissioner Murray later directed that representatives of both APEP and RCA

Union, continued

formula which takes into consideration economic value, career value and merit value of an engineer.

The economic value would recognize that salary is a measure of an engineer's value. The career value would recognize that an engineer's value can also be measured by the relation between his salary and the salaries of other engineers with equal experience. Merit value would recognize that an engineer's value can also be measured by the size of his merit increase.

The plan would also take into consideration education and experience—a certain number of points being given for a B. S.; a higher number of points for an M. S.; and the maximum number of educational points for the Ph. D. Experience would be calculated on the basis of 0.1 points/yr. of tenure. No agreement has been reached on this proposal.

Members of APEP are picketing the RCA plants at Moorestown, Camden and Cherry Hill. They are also picketing the RCA Building in New York. Thus far, picketing has been without incident. Virtually none of the engineers and scientists represented by APEP have crossed the picket lines to go to work, in spite of the fact that RCA management has vigorously been attempting to organize a back-to-work movement.

What the Union Settled For

July 22, 1958

THE Assn. of Professional Engineering Personnel (APEP) reached an agreement with RCA management at 9 P.M. on Saturday, July 19. The agreement was reached in the Philadelphia offices of Federal Mediator John R. Murray.

The settlement in brief is as follows:

New Salary Schedule—An average 6% general increase will be applied to all APEP personnel immediately; applied on a graduated basis. The 42 engineers and scientists now earning less than $6,000/yr. will receive an increase of 4%. 291 now earning between $6,000 and $7,000/yr. will receive 4.6%. An increase of 5.08% for 315 earning $7,000-$8,000/yr. An increase of 5.5% for 350 earning $8,000-$9,000/yr. An increase of 6% for 282 earning $9,000-$10,000/yr.

The 204 engineers and scientists now earning $10,000-$11,000/yr. will receive an increase of 6.5%. The 366 engineers and scientists now earning in excess of $11,000/yr. will receive an increase of 7%. All increases are effective as of July 21, 1958.

With the new increases, the average earnings of engineers and scientists represented by APEP will be approximately $10,000/yr. The top earnings will be $18,700/yr., with 15 people in the bargaining unit at the top of the salary range.

Another Increase Jan. 1, 1959—Effective Jan. 1, 1959, a 1% across-the-board increase will be applied to the entire bargaining unit.

Merit Review Plan—APEP and the company will jointly develop a merit review plan to be instituted sometime early in 1959. The agreement stipulates that merit increases in the future are to be determined by the score on the merit review form to be developed as part of this plan. This score system will

Company, continued

be present for a further meeting in his office at 11 A.M. tomorrow.

All RCA employees not members of the striking union again were on the job today, although picketing continued at the RCA plants in Camden, Cherry Hill and Moorestown, N. J. An apparent back-to-work movement developed with some sections reporting as high as 50% engineering personnel attendance.

Meanwhile, the principal unsettled issue remains a merit increase plan, the RCA spokesman said. He said the union continues to demand a guaranteed merit increase fund.

The company agreed that it would develop and install a formalized merit increase program and in the interim period individual merit increases granted by the company would not fall below an estimated minimum.

All other prime issues virtually have been settled, the RCA spokesman said, including the matter of a general wage increase. The union has reduced its general salary increase demand from 15% to 6%. RCA originally offered a 4% general raise.

With a 6% general increase the average salary of the employees, reported by the association, would be over $10,000/yr. with a maximum in the bargaining unit in excess of $18,500 annually.

July 10, 1958

The Radio Corporation of America today asked the Federal District Court in Camden to rule whether the amount of merit increases to members of APEP is subject to arbitration under the labor agreement between the company and the union.

Before the recent contract negotiation commenced, the union filed a grievance with the company claiming that the merit increases granted by the company last September were not satisfactory. The union is now attempting to take this grievance to arbitration despite the company's position that the amount of such increases is not subject to arbitration under the agreement, although the eligibility of personnel for merit increases is.

When informed of RCA's position the American Arbitration Assn. indicated that under its established rules the union's grievance must go to arbitration unless halted by appropriate court action.

After an Enforced Silence

July 18, 1958

BOTH RCA and the APEP union are under an unqualified commitment to the federal mediator not to issue statements to the press concerning current negotiations. Nonetheless, for its own reasons APEP has seen fit to violate this agreement repeatedly.

When, in contradiction to the actual facts, we are being blatantly and repeatedly accused of refusing to bargain in good faith, we feel that in all justice we must break our silence at least to the extent of making clear the following facts.

RCA has for many long weeks, extending through marathon sessions into the present, sought to negotiate an equitable settlement with the APEP union.

We have always believed that it was unnecessary for the union to have called out on strike the profes-

Union, continued

also be used to determine retention credit in the event of a layoff. Merit review score of any individual will be subject to the grievance procedure.

The company has agreed that any reduction in the amount of merit increases as a result of economic conditions will not affect members of APEP more adversely than other groups at RCA. It has also agreed to discuss the reasons for reduction in merit increases with APEP before such reductions are instituted.

Layoff and Rehiring—The layoff and rehiring procedure which was agreed to by the parties permits bumping between locations in the Camden area of RCA's works against anyone within the same job classification with less than 1 yr. of service credit.

Within any one location any individual may bump down into a lower classification.

The parties have also agreed to establish an area-wide recall pool. The company has agreed that it will not hire into any given classification for any location within the bargaining unit until this pool is exhausted.

Retention Credits—Retention credits for layoff and rehiring procedures will be based on:

1. Engineering value points computed on the basis of the engineer's salary relative to the salary of other engineers within the same classification with comparable years of experience.
2. Merit review points as determined from the merit review form. The average of the last three merit ratings, or the last one, whichever is the higher, will be used in the determination of retention credit.
3. Points earned by education, length of service and engineering experience.

Medical Benefits—Hospitalization and medical-surgical benefits are improved in the new agreement.

Retirement Plan—Improvements were made in the retirement plan in the agreement.

Insurance Benefits—It was agreed by the parties that all of the insurance benefits which the members of APEP enjoy are to be considered to have been in effect during the strike.

Grievance Procedure Improved—The grievance procedure was improved to provide definite time limitations for each step in the procedure.

Definition of an Engineer—The definition of an engineer is to be expanded in the new contract to include engineers and scientists in the Research and Development Depts. of RCA who have not in the past been represented by APEP by virtue of the fact that they were not engaged in research and developmental work. The unit will now include human engineers (combination engineer-psychologist), certain classes of high-level mathematicians, etc.

Payment for Invention—The parties agreed that any engineer or scientist represented by APEP will be paid the sum of $50.00 for each invention.

Overtime to Be Optional—The parties have agreed that overtime work shall be optional to the extent that any engineer or scientist can refuse to work overtime when requested to do so by the company without adverse affect on his merit review or promotability.

No Reprisals, Contract Term—The parties agree that there shall be no reprisals against any individual because of activities during the strike. The contract expires on July 1, 1959.

Company, continued

sional engineers, most of whom were engaged in work on critical defense contracts.

We deplore the irresponsible distortion of facts to which the striking engineers and the community have been subjected. For example, in a special note APEP accuses the company in intemporate language of bringing pressure against those union members who have a deferred draft status because of their critical work on defense contracts. The truth is that we have done nothing of the sort. One draft board on its own initiative notified one of the striking engineers that because his status has changed he was being re-classified to 1-A.

When he notified his supervisor of this action, RCA applied to Selective Service for continuation of the deferred status of this man.

As Interpreted by Professional Engineers

National Society of Professional Engineers
2029 *K Street, N. W.*
Washington 6, D. C.

Aug. 5, 1958

THE recent two-week strike of engineers and scientists employed by RCA in its Camden area operations is further confirmation of NSPE's long-held viewpoint that professionalism and unionism are incompatible, according to a statement issued today by Clark A. Dunn, P. E., president of NSPE.

In response to requests* for NSPE comment upon the strike, Dunn said that wherever unionism has spread to engineers, it has been followed by strikes, picket lines and other usual union tactics.

"It has long been obvious that if engineers want unions they must be prepared to accept the consequences," Dunn said. "It is foolhardy to pretend that the concepts of professionalism can survive or flourish in an atmosphere of collective bargaining. This latest strike is nothing new in proof of our comment. It was, in fact, the sixth strike by an engineers' union in the past five years."

The NSPE spokesman added that the society has urged upon professional engineers a realization that they cannot have their cake and eat it too. He said *that the evidence shows that many of the present* engineering unions proclaim their devotion to professional concepts, but the recent strike, added to others, plus demonstrations and other union tactics, show that such a claim, even if sincere, is a mirage and a delusion.

"These comments are not intended to indicate any opinion regarding the validity of the matters at issue in the strike or to say which party was at fault. The purpose of these statements is to emphasize the firm belief of NSPE that the only professional method of solving grievances between professional engineer and employer is through the development of effective communication between the engineers and management."

* The above statement by an official representative of NSPE was initiated by a request from *Chem. Eng.* to Milton F. Lunch, Legislative Counsel for the society. The American Institute of Electrical Engineers referred us to Engineers Joint Council for comment. EJC, while declining to comment on this particular situation, referred us to their May 1956 report, "Raising Professional Standards and Improving Employment Conditions for Engineers," which summarizes EJC policy in the general area of employment conditions for engineers.

APPLICATION HINTS:

Ways to simplify construction and cut costs with Flexpipe

Flexpipe helps meet tough piping problem in air conditioning an existing building

THE PROBLEM: Air conditioning an existing office building usually calls for a bit of ingenuity in design. One large New York office building decided to air condition by making provision for packaged, water-cooled units to be installed on any floor as tenants required.

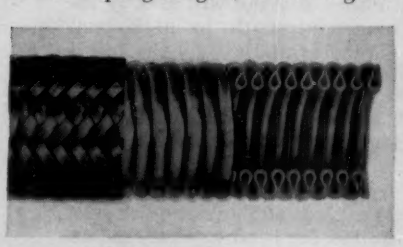
This called for four 10-inch risers, running the height of the building, to carry cooling water between the cooling tower and the branch pipes at each floor level. Because of structural conditions, the risers could not be run down through the basements and supported from below. The combined weight of pipes and the water was so great that they could not be anchored at any one point on the structure.

So the consulting engineers, Zimmermann Engineering, New York, floated the risers on spring hangers, distributing the weight evenly over all floors. This meant, however, that the risers were free to move. A riser full of water weighs several tons more than an empty one and settles about two inches.

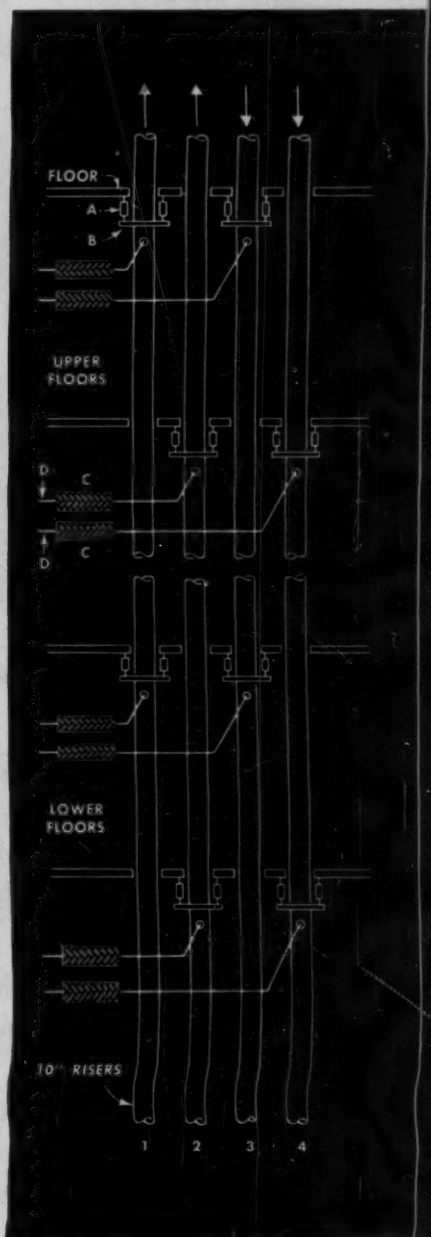
Therefore connections between risers and branch pipes had to be flexible. They also had to have strength, because water pressure at the lower floors approaches 400 psi.

THE SOLUTION: Flexpipe connectors were the answer. They provided the flexibility and the strength required. Furthermore, they were available in the sizes needed —from 5" diameter at the lower floors to 2" at the top floors.

WHERE TO BUY: Flexpipe connectors come in convenient standard sizes and are sold by leading distributors. They can show you samples and answer questions about service applications. For the name and address of the one serving your area, or for more detailed information, write to: The American Brass Company, American Metal Hose Division, Waterbury 20, Conn. In Canada: Anaconda American Brass Limited, New Toronto, Ont. 58226



FLEXPIPE'S flexible core can be either tin bronze, hot dipped galvanized steel or stainless steel. End fittings (attached): flanges, threaded males and welding nipples.



SCHEMATIC DIAGRAM showing how cooling-water risers were installed. A: spring hangers. B: pipe clamps. C: Flexpipes. D: branch pipes at each floor. 1, 2, 3, and 4: risers, 10 inches in diameter. *Upper left:* Photo of Flexpipe installation at a lower floor.

Flexpipe® an ANACONDA® product

made by The American Metal Hose Division of The American Brass Company

PRACTICE ...

CORROSION FORUM

EDITED BY R. B. NORDEN

New chromium-based alloys, under development, promise to solve many high-temperature problems.

Cr-Based Alloy Breakthrough?

A promising development in high-temperature alloys is shaping up in Australia. Scientists at the Aeronautical Research Labs. and the Defense Standards Labs. in Melbourne are working on new chromium-based alloys which stand up to temperatures of 1,750 F. and higher. In the picture above an operator is removing a chromium alloy from a melting pot.

Most of our present cobalt and nickel superalloys have a top operating limit of 1,500-1,600 F.

Intended for jet aircraft gas-turbine rotor blades, the new alloys will also find many high-temperature chemical applications. It's known that Du Pont has expressed interest in getting an option on the Australian chromium-alloy processes.

▶ **Chromium Isn't Brittle**—Chromium, with a melting point of about 3,450F., has already been tried as a basis for high-temperature alloys by research workers in England and the U. S. This work was largely discarded, mainly because chromium was nearly as brittle as glass at room temperature and no way could be found to make it ductile or malleable.

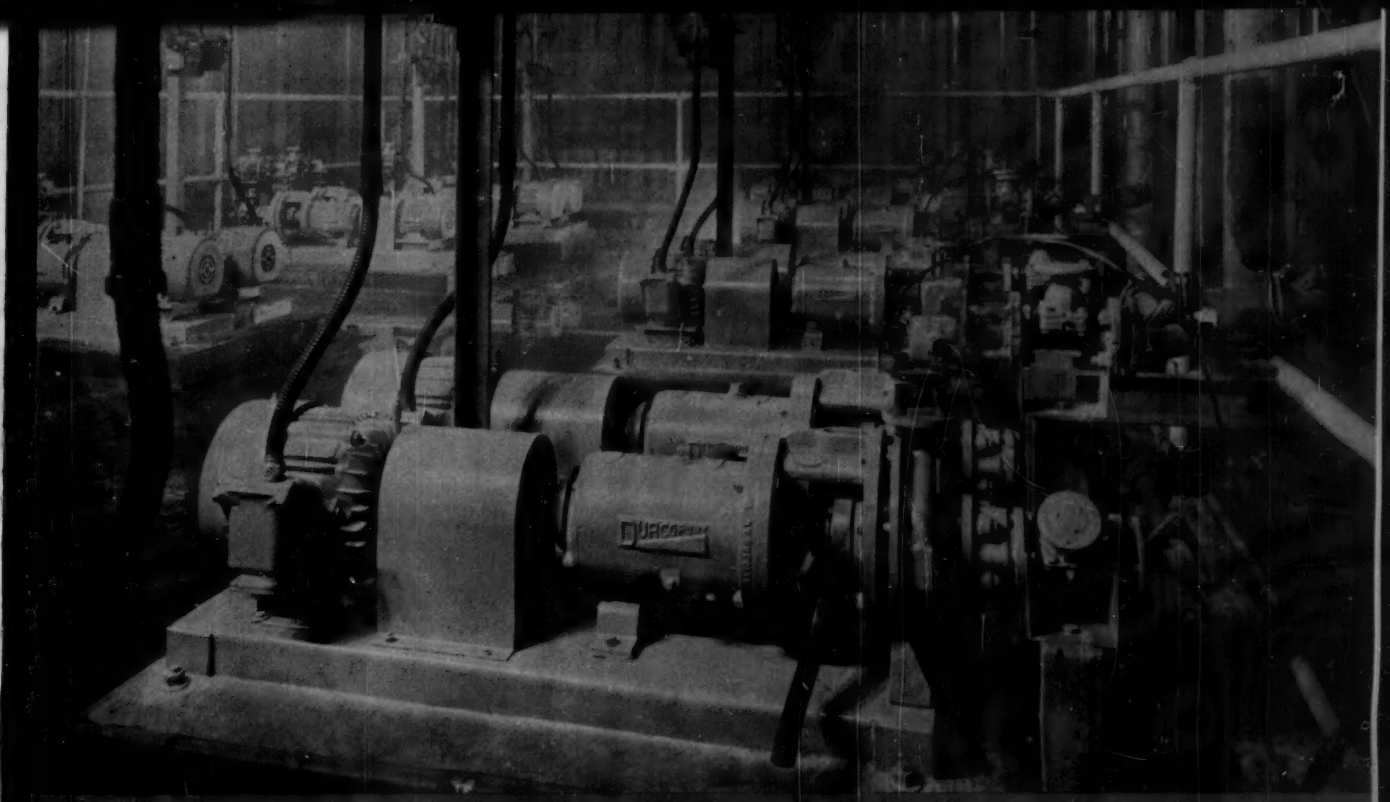
The Australian scientists have proved that chromium is not inherently brittle. They've found more than one way of removing brittleness.

In studying the reasons for brittleness of chromium at temperatures as high as 570 F., the Australians first discovered the metal could be made ductile by mechanical working at temperatures which did not permit it to become fully re-crystallized. Further studies showed pretty clearly that brittleness was largely due to very minute amounts (a few parts per million) of nitrogen in solution. When the metal was treated to precipitate the nitrogen into a suitable distribution, it became quite ductile at room temperatures.

▶ **Alloy Developments**—Considerable progress has been made on a program designed to find out how alloying additions affect the high-temperature properties of chromium. So far simple alloys have been made with high-temperature strengths better than those for the best of conventional alloys.

The teams say there is "every reason for confidence that further alloying will greatly increase strength in high temperatures and extend the feasible temperature range upward."

▶ **New Process Techniques**—The program has included design of a semi-automatic plant to produce, by a carefully controlled electrolytic process, chromium of the high purity required for fundamental studies. There is a new furnace design for melting the chromium under



THIS IS A PUMPING STATION AT CARBORUNDUM METALS COMPANY. HERE ARE A FEW OF THE MORE THAN FORTY SERIES H DURCOPUMPS USED IN THE PRODUCTION OF ZIRCONIUM. THESE PUMPS HANDLE $ZrOCl_2$ TWENTY-FOUR HOURS A DAY, SEVEN DAYS A WEEK. THE AIR IN THIS AREA IS CONSTANTLY FILLED WITH CORROSIVE CHEMICAL VAPORS. EVEN WITH THIS HARD USE AND CHEMICAL ABUSE, DURCOPUMPS REQUIRE AN ABSOLUTE MINIMUM OF MAINTENANCE.

Series H Durcopumps are chemical pumps all the way. They are designed and built to give long, trouble-free life when handling tough corrosives. They have a large, rugged shaft with minimum deflection, heavy duty bearings, integral suction and discharge with casing support. Durcopumps are adaptable to either packing or mechanical seal.

These pumps are available in twelve standard alloys with interchangeable wet end parts. Capacities range from ½ to 3500 gpm, and heads to 345'. When you have a chemicals handling problem, and want long, dependable pump life, call the Durco service engineer.

DURCO
CORROSION RESISTING ALLOYS & EQUIPMENT

The mark of dependability in tough chemical service . . . everywhere

THE DURIRON COMPANY, INC. / DAYTON, OHIO

Branch Offices: Baltimore, Boston, Buffalo, Chicago, Cleveland, Dayton, Detroit, Houston, Knoxville, Los Angeles, New York, Pensacola, Philadelphia, and Pittsburgh.

a mixture of argon and helium, in addition to procedures for introducing alloying additions and for working down the ingots to rod, wire and sheet form for testing purposes.

What's Your Rust Index?

Comparative rates at which rust proceeds in different parts of the country, have been established for the first time for all U. S. cities over 10,000 population.

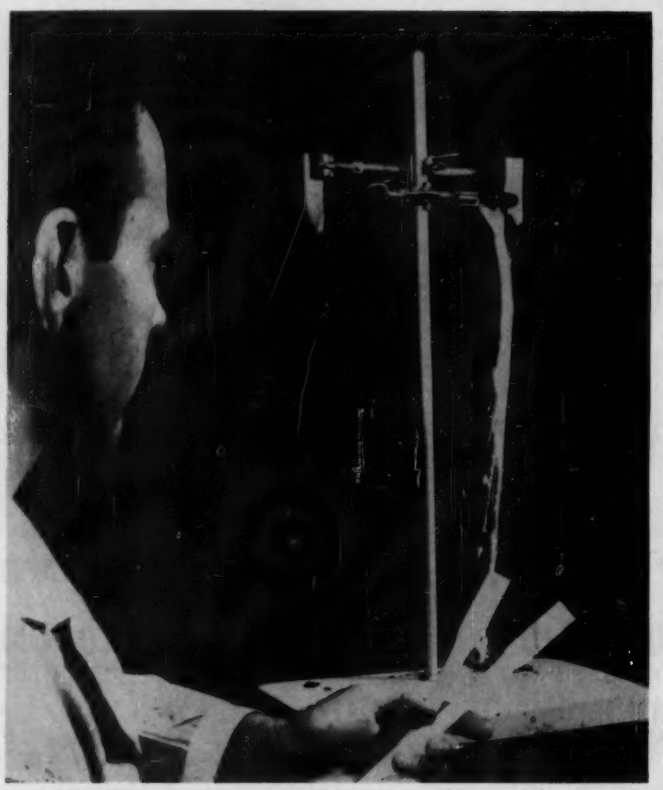
It takes three years, the fastest rate in the country, for rust to corrode a standard, uncoated steel test panel, the size of an auto license plate, in four different cities—Buffalo and Rochester, N. Y.; Erie, Pa.; and Miami, Fla. Slowest rust rate, more than 15 yr., is in Tucson, Ariz.; Roswell and Santa Fe, N. M. In all the nation's major industrial centers the rust rate is under four yr.

This was disclosed in the first Rust Index of the U. S., prepared by the Rust-Oleum Corp., Evanston, Ill. The Index, the result of a 25-year research program, lists the 523 cities of the country with a population of more than 10,000 and the comparative rust rate for each city. Variations in rate result from the different amounts of rainfall, wind, corrosive gases, sunlight, and salt water present in each locality.

The rust rate is three yr., one mo. in Pittsburgh; three yr., two mo. in Los Angeles; three yr., three mo. in Cleveland; three yr., five mo. in Chicago; three yr., six mo. in New York City; three yr., eight mo. in Philadelphia and Detroit; three yr., nine mo. in San Francisco; and three yr., 10 mo. in Boston and St. Louis.

Rust-Oleum Corp., which produces rust-preventing coatings, estimates the nation's rust bill as currently about $7½ billion per year, an increase of $2 billion over the annual toll 10 yr. ago.

The index was compiled in a large research program, in which dated and uncoated steel panels were left exposed at industrial sites throughout the country. The panels were of 28 gage, low carbon, cold-roll sheet steel. Thousands of panels were dated and left exposed. Periodic examination of the panels provided the data for the Rust Index. Criterion for the Index was the time it took for the uncoated steel panel to rust to a severe degree.



New Polyethylene Resists Combustion

A new flame-retardant high-density polyethylene is immediately self-extinguishing after removal of a 30-second applied flame (left). Ordinary untreated high-density polyethylene continues to burn (right).

Developed by W. R. Grace (N. Y.) and now commercially available in a range of colors, the novel material has been used in tanks (cylinder heads) containing nitrogen, oxygen and acetylene. Other possible applications: ducts, piping, linings.

International Plastics Standardization Meeting

Plans are now complete for an International Symposium on Plastic Testing and Standardization to be held in Philadelphia Oct. 30-31, 1958.

The program is sponsored by ASTM on behalf of the American Group for the International Organization for Standardization (ISO). Sessions will include such topics as test methods for engineering properties; thermal properties of plastics; methods for molecular characterization (*Continued*).

USCOWELD PLASTIC PIPE FITTINGS

Greater Joint Strength—Faster Insertion—Thanks to

THE ONLY SOLVENT-WELD FITTING WITH AN INTERFERENCE FIT!

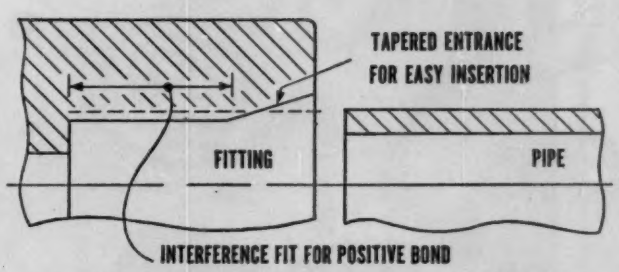
To get maximum joint strength, interference fit is a must! UscoWeld fittings are designed to provide at least a .005 inch *interference fit.* And UscoWeld fittings are a cinch to install because of a specially designed *tapered entrance socket.* U.S. Rubber has developed the unique UscoWeld fitting of the same tough, lightweight, corrosion-resistant thermoplastic as famous Uscolite® CP plastic pipe.

All UscoWeld fittings can safely handle the pressures recommended for the corresponding size of extra-heavy Uscolite pipe. Maximum recommended operating temperature is 170°F. Pipe can be cut to exact length, is easily installed in close quarters.

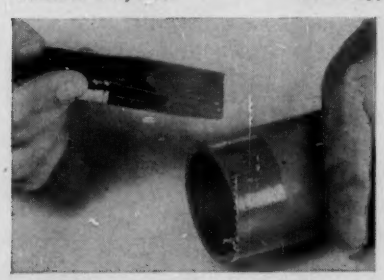
UscoWeld*—plus the most complete line of plastic pipe and fittings in America—is obtainable through your local "U.S." Distributor, any "U.S." Branch, or write us at Rockefeller Center, New York 20, N. Y. In Canada: Dominion Rubber Co., Ltd.

*Patent applied for

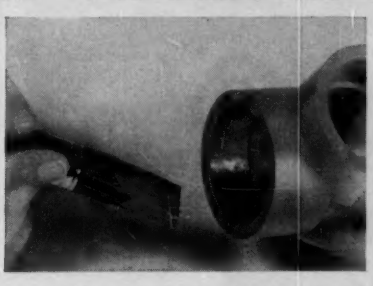
THE USCOWELD PRINCIPLE



By combining tapered entrance socket and a .005 inch interference fit—even when the pipe is at the small limit of the diameter tolerance and the fitting at the large limit of its diameter tolerance—UscoWeld is easily installed, and the strongest solvent-weld joint available.



Apply Uscolite CP cement to the outside area of the pipe that is to be in contact with the socket.



Next apply cement uniformly to entire inside area of *tapered entrance* socket.

While both cemented surfaces are still wet, insert pipe in fitting and push until pipe bottoms against shoulder in the fitting.

ADVANTAGES

- fast, easy to assemble—tapered entrance provides easy insertion of pipe
- strong joint—interference fit provides for optimum fusion of pipe and fitting into homogeneous mass; joint strength not dependent on cement alone
- automatic alignment of pipe and fittings
- chemical resistance of the UscoWeld joint is the same as for Uscolite pipe
- UscoWeld takes maximum advantage of the inherent "solvent-weldability" of plastic pipe and fittings
- no threading required—just cut pipe square
- not necessary to allow for thread make-up variation—pipe can be cut to exact lengths
- easy to install in close quarters
- resists fatigue due to vibration or thermal stresses by elimination of stress concentration at thread roots.

Mechanical Goods Division

United States Rubber

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

Ultra-High Strength Steel Available

Looking for an ultra-high strength metal? U. S. Steel has developed a new steel with a tensile strength of 280,000 psi. Called Airsteel, it's made by a novel air cooling technique.

Most steels call for oil or salt quenching to develop good mechanical properties. USS metallurgists have come up with a steel containing alloying elements which allow it to harden in the open air after heating.

Commercial heats have been produced. U. S. Steel believes the new product is highly suitable for missile and chemical process applications. It's available in bars, plates and sheets.

How Zirconium Fabricating Difficulties Were Solved

Zirconium is a tough customer to work with. The problems Pfaudler ran into when fabricating the first zirconium heat exchanger point up some of the difficulties and solutions.

It's not easy to cold-form zirconium, so it had to be heated to 600-900 F. before forming. Also zirconium can't be welded to any other metal; and like titanium it has a strong affinity for oxygen and nitrogen, which makes it brittle. Tungsten-arc welding had to be performed in an inert argon atmosphere using a specially constructed welding chamber (above).

The final 11½-sq. ft. exchanger has solid zirconium bonnets and tubing, and zirconium-lined tube sheets. The 4½-in. I.D. shell is of polished Type 304 stainless steel. Tube sheets were welded to the stainless shell with the tubing protruding slightly. The tubes were then roller expanded, zirconium tube sheet lining placed over the protruding ends and seal-welded to the tubes.

New Process Sprays Any Metal

Can any known element be sprayed onto a supporting material? The answer is yes, according to the Giannini Plasmadyne Corp. (Santa Ana, Calif.) They've coated cold steel with tungsten using a new spraying technique, based on the "plasma-energy" principle.

Energy from an electric arc is transferred to an ionized gas medium creating temperatures up to 25,000 F. The hot gas forms a jet traveling at about 13,000 ft./sec. This jet is used to heat the metal to be sprayed.

Some immediate process applications (besides missiles and nuclear power) include coating of high-temperature pump and bearing surfaces, combustion chamber valves, high-speed grinding and cutting surfaces.

Butyrate Plastic Easy to Strip

A peelable butyrate plastic coating, developed for metal plating operations, should also solve some tough corrosion problems.

Previously, in metal plating, parts to be partially plated were usually dipped in a lacquer coating which calls for a relatively long drying time. Also, such coatings are difficult to remove.

Now a part is partially plated by first dipping in a bath of molten butyrate. Then it's withdrawn. The plastic coating solidifies within 60 seconds and it's easily trimmed or peeled away from the area to be plated.

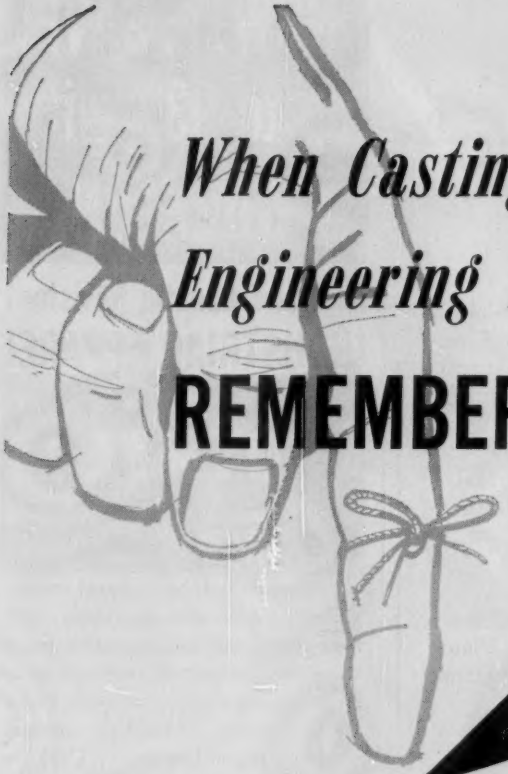
After plating, the coating is readily stripped off and returned to the melt tank for re-use.

Result has been a substantial reduction in plating time and labor costs over conventional methods.

The coating is non-exuding—it doesn't leave any residue.

Such a coating should prove useful as a protective lining for parts which will be stored in a corrosive atmosphere or as masking agents for painting.

Coating was developed by Seal-Peel, Inc., Royal Oak, Mich., using Eastman Chemical butyrate.



When Castings Become an Engineering Problem...

REMEMBER THAT

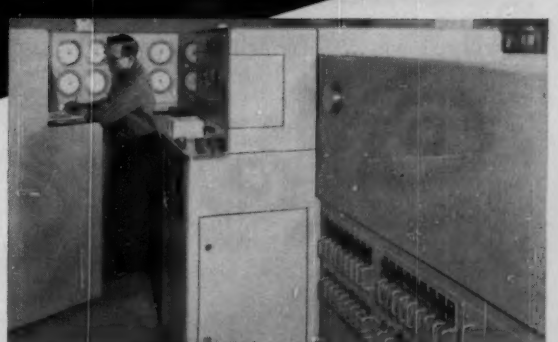
WE CAST ALL 3

There are two facts which may be highly important to you. First, WAUKESHA is comprised of three separate foundries with expert experienced, *specialized* management for each.

1. One foundry casts only Stainless Steel, 300-400 series, Ni-resist and special corrosion resistant formulations.
2. Another casts only "Waukesha Metals" (copper base, high nickel alloys), pure nickel, Monel, brass, bronze, Everdur.
3. The third casts only Aluminum — as cast and heat-treated.

Second, over all three foundries are two laboratory operations, one for quality control and the other for metalurgical research. Both work for your interests. As examples of quality control: a spectrometer checks every heat; formulations can be corrected before the metal is poured. The laboratory also controls all supplied materials.

But perhaps more important to you when you have any problem such as corrosion resistance, heat resistance, galling or machining, is the Research Laboratory. Let it suffice to say that we have solved intricate metallurgical problems for many WAUKESHA customers. And this we offer — without charge — to you. Simply send a print or a pattern and tell us your need. You have everything to gain.



The spectrometer at WAUKESHA for quality-control

Part of the metallurgical laboratories for quality-control and research

Waukesha FOUNDRY COMPANY

5805 Lincoln Ave. • Waukesha, Wis.

FIRMS IN THE NEWS

R. A. LABINE

NEW FACILITIES

October's Top Projects:

Chemical Construction Corp. will build a new ammonia-urea plant for Cooperative Farm Chemicals of Lawrence, Kan. Ammonia unit, rated at 100 tons/day, will be based on natural gas; urea plant will produce 30 tons/day for urea-ammonium nitrate solutions.

Union Carbide Chemicals plans to erect new plant at Institute, W. Va., to produce 10 million lb./yr. epoxides and other hydrogenated chemicals. Unit is scheduled for completion in mid-1959.

Columbia-Southern is building a large cement plant at Barberton, Ohio—capacity 1.5 million bbl. cement annually. Plant will use wet process, will include rotary kiln 450 ft. long and 13 ft. in dia.

Harvey Aluminum has started regular production at its new aluminum reduction facility at The Dalles, Ore. Plant capacity is more than 100 million lb./yr., features many automatic operating techniques.

Dow's Texas Div. is producing aluminum chloride in a "small facility" at Plant B in Freeport. Initial production of this catalytic agent is being consumed internally, principally in production of ethyl benzene.

Lousiana Chemical Corp. has awarded a $3-million contract to Delta Engineering Corp. for expansion of natural gas extraction plant near Magnolia, Ark. Firm operates plant for Columbia Products; expansion will add ethane recovery facilities to the installation.

Monsanto's Lion Oil Div. plans a multimillion-dollar expansion of its El Dorado, Ark., refinery. Program will boost rated crude throughput from 29,000 to 33,000 bbl./day and will include new hydro-desulfurization, decarbonization and tetramer units.

Aluminum Co. of America's Massena, N. Y., smelting operation became first industrial consumer of electricity from long-awaited St. Lawrence Seaway Project. Alcoa built new facilities to utilize new power source, brings total capacity at Massena to 54,000 tons/yr. aluminum.

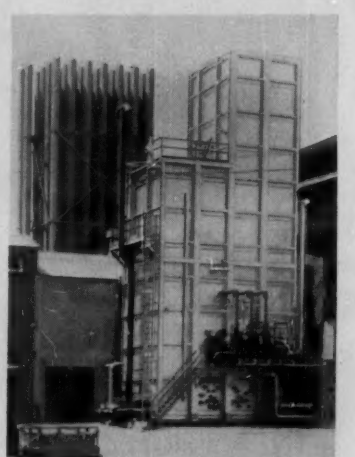
Dow has started production of iminodiacetic acid at its Midland, Mich., plant; is believed to be only commercial producer. Acid finds use as intermediate for surface active agents, complex salts and chelating agents.

Carborundum's expanded facilities at Niagara Falls for manufacturing boron carbide are now in full operation. Accelerated production was precipitated by industrial advances demanding this abrasive—exceeded only by the diamond in hardness.

General Electric is building a $1 - million radiochemistry building at the 300-acre

atomic plant in Hanford, Wash. New structure will house advanced research including high-level radiation work up to 1 million curies.

Heyden Newport's Nuodex Products Co. is expanding production facilities at Elizabeth, N. J., for nickel catalysts and plating salts. Line now includes nickel sulfate, chloride, formate, carbonate, nitrate and acetate.



Granite City Steel Co.'s latest addition is a 60-million-cu.-ft./mo. oxygen generating unit built by Air Products. Most of output is being piped to company's seven open hearth furnaces.

Air Reduction has upped daily production capacity at its Lorain, Ohio, gaseous and liquid oxygen plant to 100 tons/day. Most of increased output will be soaked up by local steel makers.

British American Oil Co. is about to open two plants this month valued at $50 million: B-A's natural gas processing plant at Pincher Creek in southern Alberta will be dedicated Oct. 15th. Company's new 20,000-bbl./day refinery just outside Vancouver, B. C., is going through test runs for its official opening Oct. 17th.

Manhattan Adhesives Corp., Brooklyn, N. Y., has placed its new polyvinyl acetate and

resins plant in full production to furnish complete line of polyvinyl solutions and emulsions.

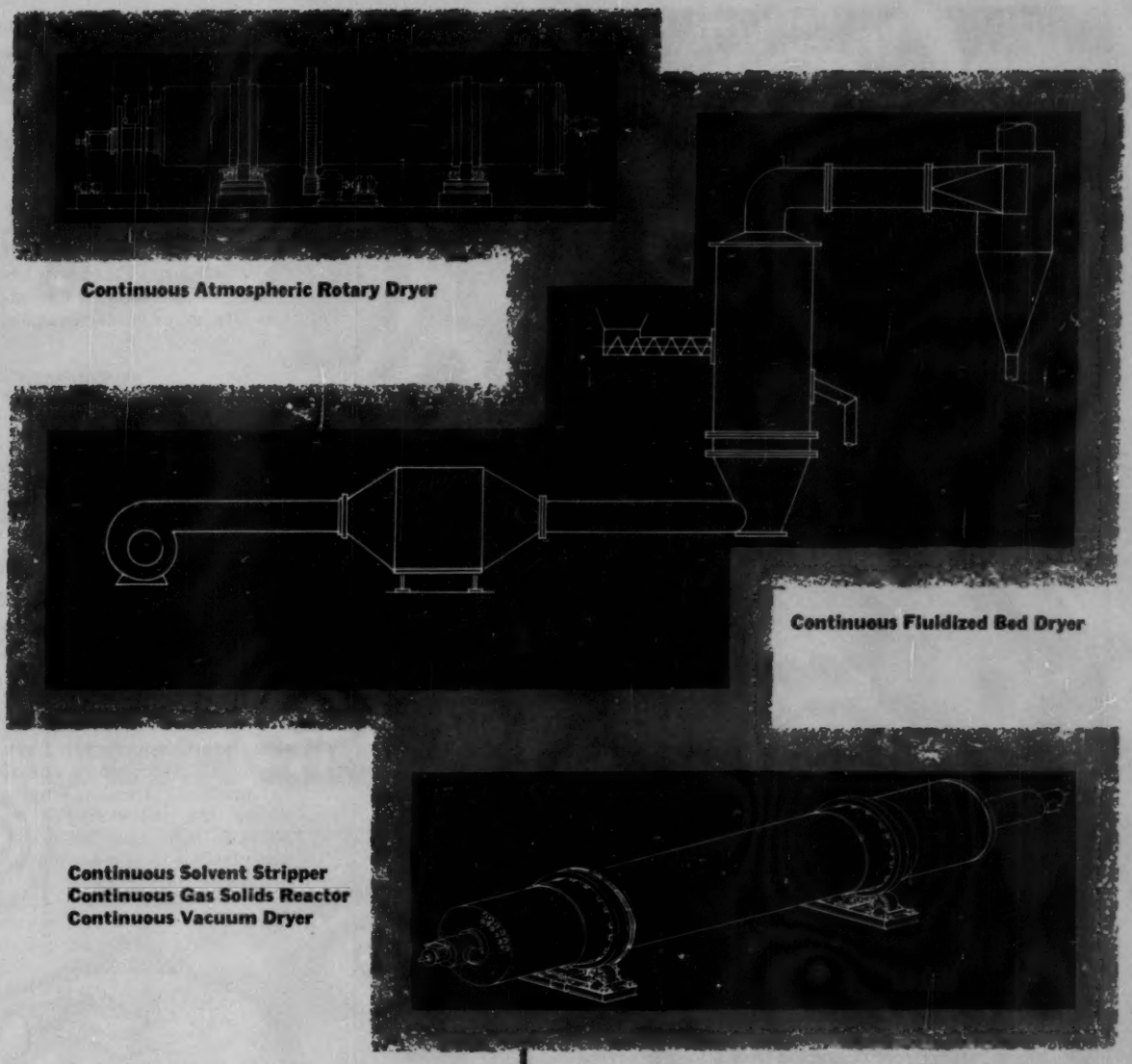
U. S. Steel's Gary, Ind., Works boasts a new 94-million-cu.-ft./mo. oxygen plant built, maintained and operated by Linde Co. Oxygen will be used in cutting, scarfing, scrap preparation and other metallurgical processes.

Texaco announces completion of "world's most fully equipped industrial radiation research laboratory" at firm's research center in Beacon, N. Y. Lab will probe atomic structure of petroleum and its derivatives with view towards improving fuels, lubricants and petrochemicals.

MERGERS & ACQUISITIONS

Chromalloy Corp., White Plains, N. Y., has acquired Propellex Chemical Corp. of Edwardsville, Ill., through a stock exchange. Continuing as Propellex Chemical Div., firm is producer of solid propellant rockets and fuels, and other propellant and explosive devices.

A. E. Staley Mfg. Co. of Decatur, Ill., has purchased the Hipolite Co. of St. Louis. Manufacturing facilities for Hip-O-Lite Marshmallow Creme are being moved from St.



Continuous Atmospheric Rotary Dryer

Continuous Fluidized Bed Dryer

Continuous Solvent Stripper
Continuous Gas Solids Reactor
Continuous Vacuum Dryer

Now, at one convenient location, you can test-dry your materials in a variety of equipment

At General American's East Chicago pilot plant, you can test the drying or reacting of your materials in the widest range of drying equipment ever assembled in one place.

Louisville Dryer engineers will work with you—study your materials and needs, make recommendations for type of equipment, size and heating medium. You can check these recommendations for yourself through practical tests. Your Louisville Dryer is then engineered for most efficient and economical service—built specifically to meet your needs.

To test the drying of your materials in all these different types of drying equipment, call in a Louisville Dryer engineer. There is no cost or obligation.

PROCESS EQUIPMENT DIVISION GENERAL AMERICAN TRADE MARK

LOUISVILLE DRYER DIVISION
GENERAL AMERICAN TRANSPORTATION CORPORATION
135 South La Salle Street, Chicago 90, Illinois
Offices in principal cities

FIRMS . . .

Louis to Decatur and product will be added to Staley's grocery line.

Du Pont has purchased the idle Cornwells Heights, Pa., sulfuric acid plant of Cornwell Chemical Corp. Plant will become part of Grasselli Chemicals Div. after modernization.

NEW COMPANIES

Plastic Coated Paper Corp., with headquarters in Hicksville, L. I., is a new firm specializing in polyethylene coatings. New plant, to be finished by late 1958, will coat paper, board and foil in addition to other materials.

Union Bag-Camp Paper Corp. has established a new chemical products division emphasizing the increasingly important role that chemicals are playing in company operations.

NEW LINES

Pacific Vegetable Oil Corp. is diversifying in the urethane polymer field through its recently acquired interest in Polytron Corp. New affiliate will manufacture urethane polymers and will conduct research on new urethane derivatives.

S. C. Johnson & Son, wax makers, has purchased patent rights to Porelon, a new synthetic material with "abundant product possibilities." Porelon is claimed to be first synthetic in which liquid can be trapped during manufacture, then given off at predetermined rate. Product possibilities include marking stamps and self-lubricated bearings.

CALENDAR

American Society of Mechanical Engineers-American Society of Lubrication Engineers, Lubrication Conference, Statler Hotel.
Oct. 13-15 Chicago, Ill.

American Gas Assn., annual convention.
Oct. 13-15 Atlantic City, N. J.

Packaging Institute, 20th annual forum, Edgewater Beach Hotel.
Oct. 13-15 Chicago, Ill.

Society of Industrial Packaging and Materials Handling Engineers, annual national exposition, Coliseum.
Oct. 14-16 Chicago, Ill.

National Assoc. of Corrosion Engineers, North Central Regional Conference.
Oct. 15-17 Cincinnati, Ohio

Instrument Society of America, National Rubber and Plastic Symposium.
Oct. 20-21 Akron, Ohio

Technical Assn. of the Pulp and Paper Industry, 13th Plastics-Paper Conference, Sheraton-Kimball Hotel.
Oct. 20-22 Springfield, Mass.

American Oil Chemists Society, fall meeting, Sheraton Hotel.
Oct. 20-22 Chicago, Ill.

National Assn. of Corrosion Engineers, South Central Regional Conference and Exhibit.
Oct. 20-24 New Orleans, La.

American Vacuum Society, 5th National Vacuum Symposium, Sir Francis Drake Hotel.
Oct. 22-24 San Francisco, Calif.

American Institute of Chemical Engineers, New York Section, All day symposium: Cost Engineering, Foams and Froths, Petroleum Chemicals; luncheon speaker: George Holbrook, AIChE President; Hotel Statler.
Oct. 23 New York, N. Y.

National Society of Professional Engineers, fall meeting, St. Francis Hotel.
Oct. 23-25 San Francisco, Calif.

National Metals Exposition, Cleveland Public Auditorium.
Oct. 27-31 Cleveland, Ohio

Assn. of Consulting Chemists and Chemical Engineers, annual meeting, Biltmore Hotel.
Oct. 28 New York, N. Y.

National Agricultural Chemicals Assn., 25th annual meeting, Bon Air Hotel.
Oct. 29-31 Augusta, Ga.

American Society for Testing Materials, International symposium: Plastics Testing and Standardization, Benjamin Franklin Hotel.
Oct. 30-31 Philadelphia, Pa.

Industrial Management Society, 2nd annual seminar on Executive Techniques of Industrial Engineering, Hotel Sherman.
Nov. 4-5 Chicago, Ill.

Each of these mixers weighs over four tons, yet they are so perfectly balanced they stand alone on their supporting blocks. Side support is not required. This means minimum stress on tank top flanged nozzles which support the mixers.

EXPANDED ESSO ALKYLATION UNIT TO USE

42 PHILADELPHIA MIXERS

Forty-two vertical Philadelphia Mixers like the ones shown are being installed at the Baton Rouge Refinery of Esso Standard Oil Company by Foster Wheeler Corporation. They are part of an alkylation process in which concentrated sulfuric acid serves as a catalyst to unite light olefins and isobutane to produce high octane gasoline blend stock. Installed in the various reaction zones of the reactors, they insure optimum contact of reactants.

These units are equipped with a shut-off device below the mechanical seal which permits seals to be changed with reactor vessels held at full pressure. This can be done simply and quickly, and requires *no external lifting equipment.*

For this, or any other fluid mixing job, Philadelphia Mixers offer many important design advantages.

- Extra large, heavy duty bearings throughout permit every drive component to be designed to required degree of stiffness. The strength and rigidity of drive assemblies keep gearing effectively isolated from unbalanced output shaft loads which might cause damage.
- Extremely heavy output shafting keeps shaft deflection to an absolute minimum, even under heavy unbalanced mixing loads.
- Extra long output shaft bearing span insures precision shaft operation and minimum runout in the seal area.
- All gearing is induction hardened and ground or crown shaved for long, quiet, trouble free life.
- Quick change gear sets are available from stock to furnish 14 standard AGMA output speeds.

To select the exact mixer for your process needs, write for Catalog A-27. It contains all the information needed to make a catalog selection of a complete mixer assembly.

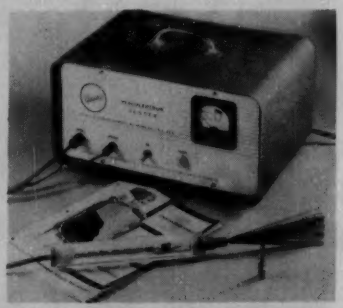
PHILADELPHIA GEAR CORPORATION
Erie Avenue and G Street • Philadelphia 34, Pennsylvania

philadelphia mixers

Offices in all Principal Cities • Virginia Gear & Machine Corp., Lynchburg, Va.
INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS

NEW EQUIPMENT . . .

(*Continued from p. 74*)

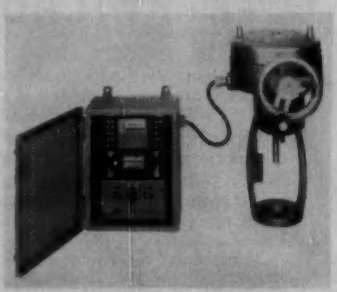


Glass Tester

Electronic unit checks glassed-steel continuity.

Known as the Pfaudlertron, a new constant-voltage electronic tester checks the surface continuity of glassed-steel equipment. The non-destructive instrument is claimed to be the first unit available for such service in the field.

Testing procedure consists of methodically sweeping the brush-type probe over the glassed surface. When a defect is present, a neon bulb in the probe handle glows with unmistakable brightness. Prolonged inspection will not endanger equipment or personnel. Stabilized output is 3,500 v., a.c.—**The Pfaudler Co. Rochester, N. Y.** **176A**



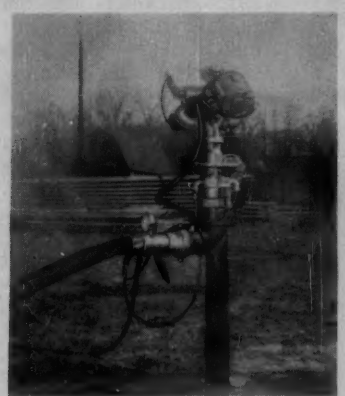
Valve Positioner

Designed to operate from electric controllers.

All electric, a new valve positioner eliminates need for auxiliary hydraulic and pneumatic systems. Transistorized and explosion-proof, the positioner incorporates a unique braking system that prevents valve oscillation and assures repeatability to within ¼%. A 1/40-hp., 2-

phase induction motor drives the unit's actuating shaft through an efficient gear train and ball-screw mechanism. Built-in limit switches prevent valve damage.

Stroke is field-adjustable from ½ to 2 in.; stem speed is 0.15 in./sec. and maximum thrust is 1,000 lb. — **Norwood Controls Div., American Standard Products, Norwood, Mass.** 176B



Remote Firefighter

New system quenches intensely hot fires.

An urgent outgrowth of the U. S. missile program, the new Akron system for remote fire fighting may soon find application in the process industries. Designed for rapid combat of fires that are too hot or too dangerous to allow human firefighters to work at close range, the foam-throwing units now stand guard at Cape Canaveral.

Mounted at the base of the launching stands, the systems are claimed to be completely automatic. Remote controls, placed in the observation bunker about ¼ mile away, raise, lower, and rotate the units, and also change stream widths.—**Akron Brass Mfg. Co., Wooster, Ohio.** 177A

Dry Classifiers

Two new machines feature high efficiency.

No moving parts, virtually no required maintenance and exceptionally low power requirements are just some of the advantages claimed by the

NEW EQUIPMENT . . .

manufacturer for two new dry classifiers. Designed for high-efficiency separation of dry fines from coarse materials, both machines can handle from 100 lb. to 100 tons of feed per hour.

One unit, the Gravitational-Inertial classifier, operates best in the 200- to 50-mesh range. Air- or gas-entrained feed enters through a top inlet and cascades down a set of inclined vanes through which air and fines are drawn off. Secondary air introduced below the vanes scrubs remaining fines from the coarse material leaving the classification zone. Regulation of the velocities of exhaust and secondary air establishes the cut point.

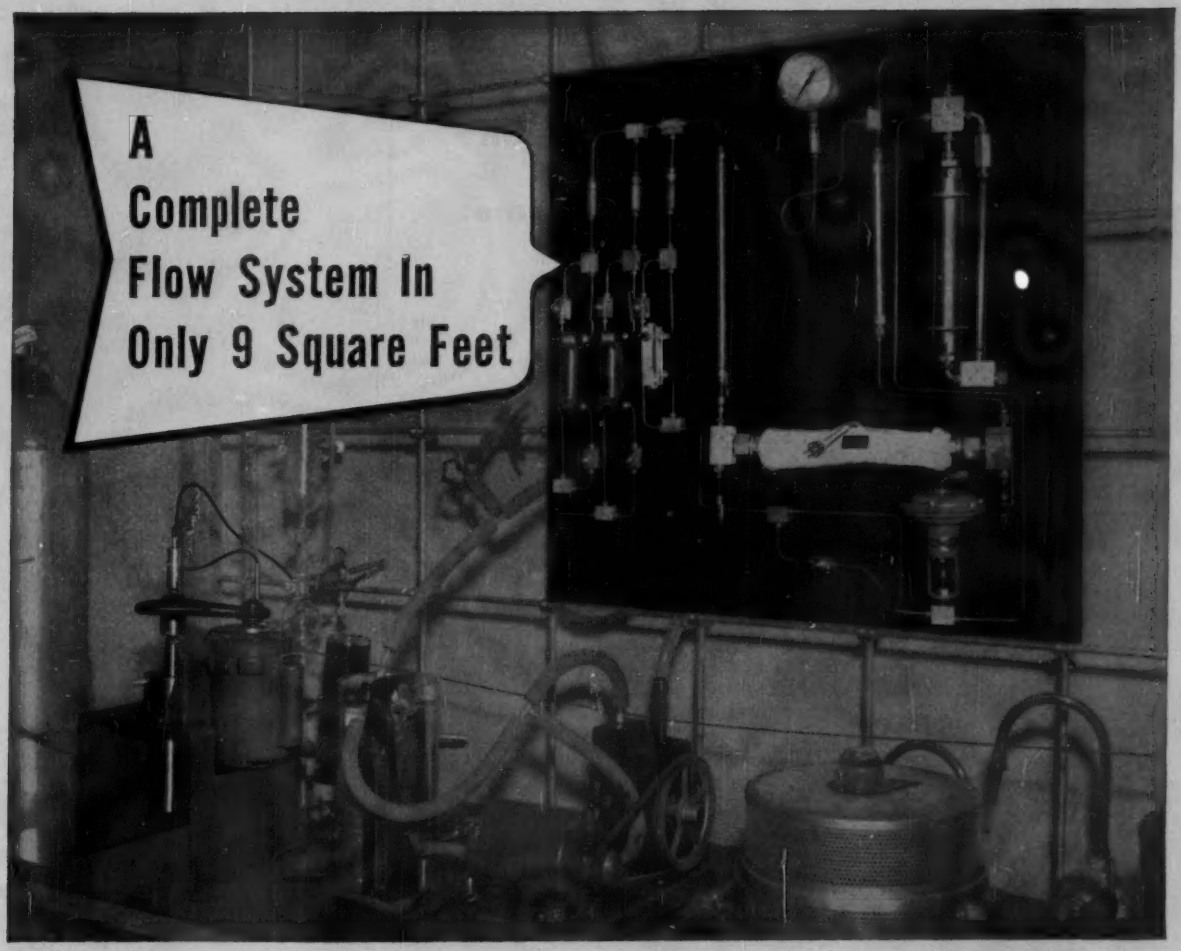
Initial installations of the other classifier, a centrifugal-type unit, indicate mill output increases from 10 to 300%. This machine will extract more than 98% of the particles smaller than 325 mesh from most feeds, and with no oversize material in the fines. In operation, the combined action of centrifugal and drag forces on each feed particle affects the separation.—**Buell Engineering Co., Inc., New York, N. Y.** 177B

Shutoff Valve

Less than 10 lb. torque controls 5,000 psi.

An in-line shutoff valve, known as the Ez-O-Trol, offers easy on-off control for hydraulic circuits operating at pressures to 5,000 psi. Designed for applications where the liquid is not subject to flow reversals, Ez-O-Trol comes in sizes from ¼ to 2 in. Standard valve body is aluminum alloy; internal parts are stainless steel.

In operation, back pressure seats the valve in a balancing pressure chamber. Actuation of the pilot by application of about 10 lb. torque to the valve handle allows back-pressure escape, thus unbalancing the unit. This quickly opens the valve to flow with low pressure drop. If desired, air-operated diaphragms or direct-acting solenoids provide remote control of the pilot.—**Republic Mfg. Co., Cleveland, Ohio.** 178A



For Feasibility or Exploratory Studies In YOUR Lab...
Complete BENCH-SCALE Research Equipment From AE

To save you time, money and trouble, Autoclave Engineers now makes available to you, for the first time, *a complete integrated* line of *professionally designed* bench-scale research equipment for pressures up to 5000 p.s.i. Included are valves, fittings, autoclaves, reactors and auxiliary vessels.

This AE BENCH-SCALE equipment enables you to carry out in your own laboratory a wide variety of preliminary investigations such as feasibility studies before proceeding with scaled-up operations . . . research studies where only minute or limited quantities of expensive materials are available . . . batch, semi-batch or continuous reactions . . . and many other exploratory studies.

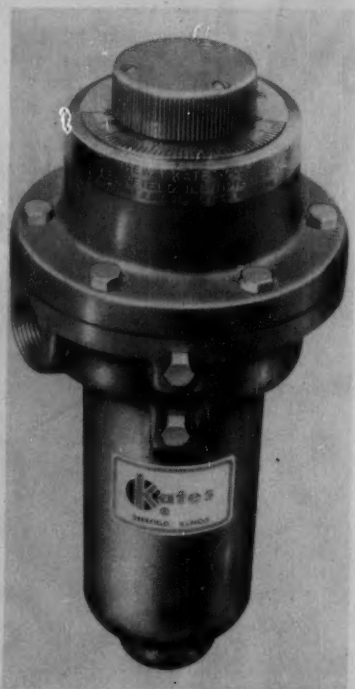
Best of all are the savings in space, time and money you'll realize with this equipment. You *save space* because every unit is specifically designed for bench-scale work. You *save time* in setting up or altering the system because of simplicity of design and resultant ease of assembly. And you *save money* because the equipment is easily and quickly assembled by your own laboratory personnel—neither skilled craftsmen nor special tools are required.

Detailed information on AE BENCH-SCALE Research Equipment is given in Bulletin 658. Send for your copy today.

AUTOCLAVE ENGINEERS, INC

2932 WEST 22nd STREET, ERIE, PENNSYLVANIA

NEW EQUIPMENT . . .



Flow Rate Regulator

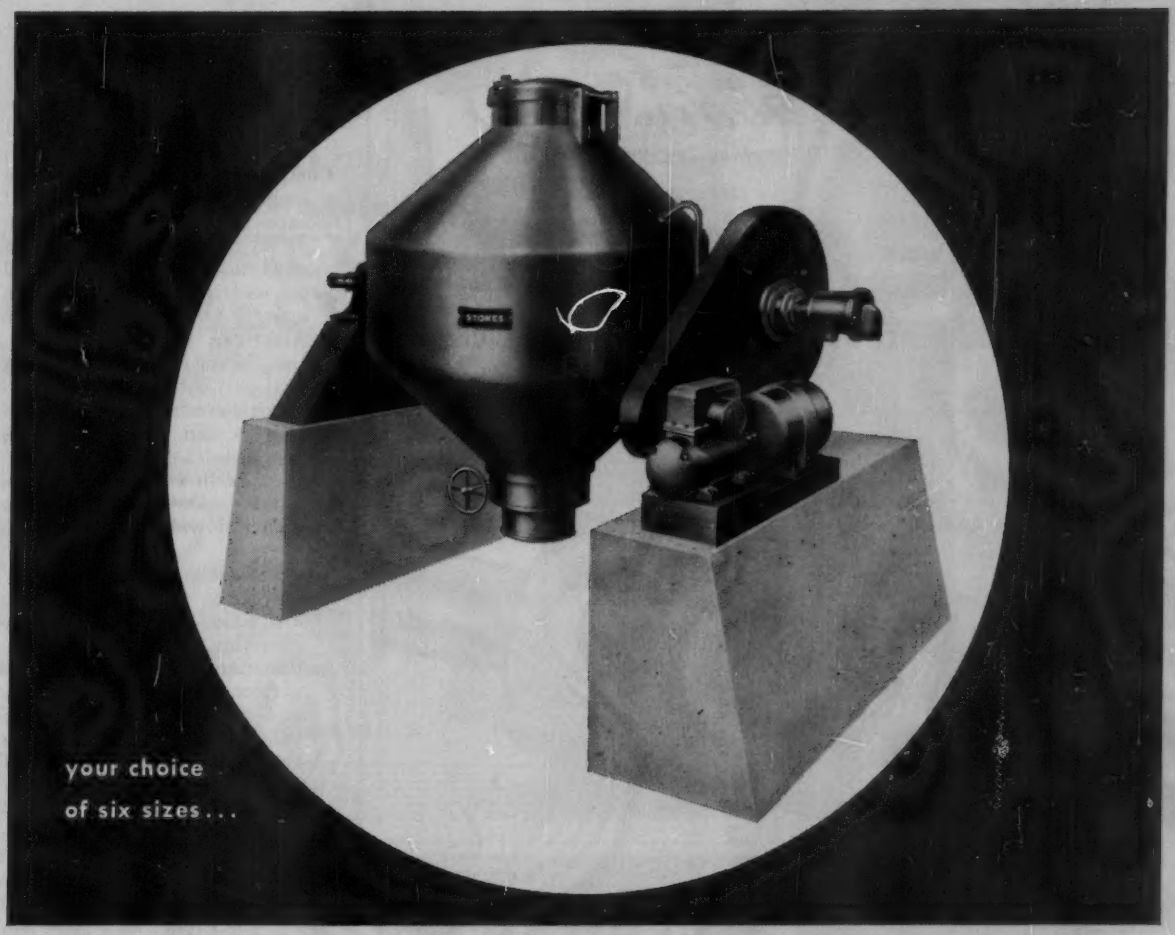
Simple, compact unit measures, controls flow.

Available for control of a wide variety of liquids and light slurries, the new Type F flow-rate regulator operates with a minimum pressure differential of less than 10 psi. It requires no outside source of power, no straight approach nor downstream piping section, and has only two-moving parts. Flow is controlled with split-second response to within 3% of set point, despite fluctuations in line pressure.

Type F regulators come in carbon steel, Type 316 stainless and special alloys for flows from 0.02 to 550 gpm. Each size provides 15:1 flow-rate adjustment by means of a calibrated dial.—**W. A. Kates Co., Deerfield, Ill.** 180A

BRIEFS

Thermistor beads, presently available in bare form with attached leads and without glass coating, function continuously at 1,200 F. Previous temperature limit was about 600 F.—**Fenwal Elec-**



Stokes Conical-Shaped Rotating Vacuum Dryers

As part of the extensive line of vacuum drying equipment offered by Stokes, this rotating cone dryer is available in six sizes. Built to Stokes' high vacuum standards, they are especially suited for those materials which require the tumbling action and/or the charging and discharging features offered by this type of dryer.

Stokes conical-shaped dryers are double-walled, and include provisions for steam or hot water heating. The interior surfaces can be supplied in carbon steel or in 304 or 316 stainless steel for use with corrosive products. The large, full-opening charging inlet is provided with a quick-acting hinged cover. The discharge port features a self-wiping vacuum-tight valve, worm-gear actuated. Every drum is vacuum tested by mass spectrometer.

STANDARD SIZES
(special sizes and materials available)

Model No.	159-1	159-2	159-3	159-4	159-5	159-6
Working Cap.*	3	10	25	75	100	150
Approx. Wt.	1,750	2,400	3,200	7,700	11,500	12,700

**In cubic feet—normal working capacity is 65% of total volume*

Call on Stokes Engineering Advisory Service for complete information and application data on these and other Stokes vacuum dryers as applied to your own production requirements.

Vacuum Equipment Division
F. J. STOKES CORPORATION
5500 Tabor Road, Philadelphia 20, Pa.

STOKES

tronics, Inc., Framingham, Mass. 180B

Compressors, with pressures from 50 to 15,000 psi. and capacities to 60 cfm., handle all types of corrosive, toxic and radioactive liquids and gases. Distributor is sole U.S. agent for French line.— **American Instrument Co., Inc., Silver Spring, Md.** 182A

Graphic symbols for control centers and panelboards are available in metals and plastics. No limitation is made on finish. — **Devco Engineering Inc., Caldwell, N. J.** 182B

Strip chart recorder-controller, featuring continuous standardization and unitized construction, comes in d.c. potentiometer, a.c. or d.c. bridge versions, and both single-pen and multi-record types. Null balance. — **General Electric Co., Schenectady, N. Y.** 182C

Centrifugal pumps for filtrate and transfer applications have a high degree of parts interchangeability. Three new designs are available: type LH for capacities of 350 and 100 gpm. at heads of 200 and 275 ft., respectively; type LR for slurries and volatile liquids; and type LX for easy removal from service without disturbance of piping.—**Dorr-Oliver Inc., Stamford, Conn.** 182D

Vertical gearmotors, rated at 3 to 30 hp. and 25 to 280 rpm., provide rugged, dependable, internally-geared power for agitator applications. Three types of motor enclosures available.—**U. S. Electrical Motors Inc., Los Angeles, Calif.** 182E

Integrator provides continuous means of automatically totaling flow. Designed for use in flowmeters receiving signals from conventional sensing elements.—**Librascope, Inc., Burbank, Calif.** 182F

Drying feeder features a cascade of heated panels that afford simultaneous rate-controlled vibratory feeding and

efficient bulk-materials, in-transit drying.—**Syntron Co., Homer City, Pa.** 182G

Vacuum dryer line features conical rotating drums. Double-walls facilitate steam or hot-water heating. Size range varies from 3 to 150 cu. ft.—**F. J. Stokes Corp., Philadelphia, Pa.** 184A

Dust collector manufacturer is converting its cyclone-separator dust collector line to radial fans. No increase in horsepower requirements or price.—**Torit Mfg. Co., St. Paul, Minn.** 184B

Motor stators, produced by casting open-type stators in an epoxy resin, are impervious to moisture and resistant to solvents, oils and most other chemicals. — **Allis-Chalmers Mfg., Milwaukee, Wis.** 184C

Equipment Cost Indexes . .

	March 1958	June 1958
Industry		
Avg. of all	231.2	230.7
Process Industries		
Cement mfg	222.9	222.2
Chemical	232.4	231.7
Clay products	216.6	216.0
Glass mfg	219.4	218.8
Paint mfg	223.8	223.1
Paper mfg	223.9	223.3
Petroleum ind	228.6	227.9
Rubber ind	231.4	230.7
Process ind. avg	228.8	228.2
Related Industries		
Elec. power equip	234.2	234.3
Mining, milling	233.8	233.1
Refrigerating	261.5	260.7
Steam power	219.5	218.4

Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago for 47 different industries. See Chem. Eng., Nov. 1947, pp. 125–6 for method of obtaining index numbers; Feb. 24, 1958, pp. 143–4 for annual averages since 1913.

For More Information . . .

about any item in this department, circle its code number on the

Reader Service

postcard (p. 197)

TECHNICAL

Comprehensive File

THE PROPERTIES OF GASES AND LIQUIDS. By Robert C. Reid and Thomas K. Sherwood. McGraw-Hill Book Co., New York. 386 pages. $10.

Reviewed by Lawrence N. Canjar, Department of Chemical Engineering, Carnegie Institute of Technology, Pittsburgh, Pa.

The average engineer, particularly the process engineer, has a file of useful information that he has accumulated over years of practice which serves as his personal reference in estimating physical properties of engineering materials. These are often coveted by the young engineers who are forced to search through countless texts and articles in order to obtain the most recent information on the estimation of a given property for some compound.

Now authors Reid and Sherwood have made such a file available to all process engineers. Not only does this text present the latest and most useful techniques for estimating physical and thermodynamic properties but quite often it discusses the relative merits of one method over another when several are presented.

In general the text is comprehensive in its coverage and complete. However, there are two areas where the authors have condensed their material to a point where the text loses its utility. In the chapter on P-V-T properties, reference is made to the latest generalized correlations but the reader is forced to refer to the original papers for the working charts and tables. There is also virtually nothing offered for the estimation of thermodynamic properties of real gases. Chapter on vapor-liquid equilibrium is complete except for multicomponent mixtures.

It is understandable that the text would be lengthened considerably by more extensive

BOOKSHELF

J. B. BACON

coverage of this material. But process engineers will be disappointed to find convergence pressure correlations missing.

For all other properties, particularly the transport properties, the coverage is excellent and manner of presentation is simple and clear. Bibliography of some 480 references is in itself a very useful compilation. Reviewer predicts enthusiastic acceptance of this text by all process engineers and advanced students in chemical engineering.

BRIEFLY NOTED

INSTRUMENT AND CONTROL ENGINEERING—Vocational and Professional Monograph. 46 *pp. By Lloyd Slater. Foundation for Instrumentation Education Research, Inc., New York, N. Y.* $1. Describes career opportunities in the field, includes 5-page bibliography.

KNOCKING CHARACTERISTICS OF PURE HYDROCARBONS. 100 *pp. American Society for Testing Materials,* 1916 *Race St., Philadelphia* 3, *Pa.* $6. Contains data on knock characteristics of a wide variety of hydrocarbons, relates structures and physical characteristics to knock limitations.

NONDESTRUCTIVE TESTS IN THE FIELD OF NUCLEAR ENERGY. 420 *pp. American Society for Testing Materials,* 1916 *Race St., Philadelphia* 3, *Pa.* $10; $7.50 *to members of sponsoring societies.* Proceedings of a symposium held in Chicago, Ill., April 16-18, 1957.

MORE NEW BOOKS

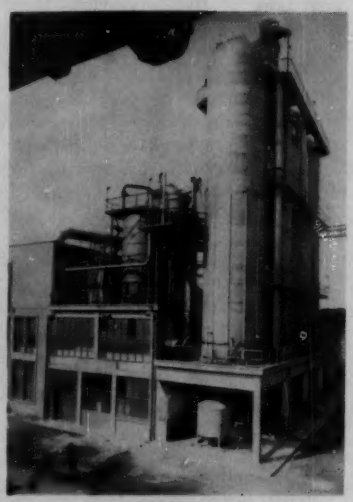
NUCLEAR ENGINEERING HANDBOOK. Edited by Harold Etherington. McGraw-Hill. $25.

FLUID DYNAMICS AND HEAT TRANSFER. By James G. Knudsen and Donald L. Katz. McGraw-Hill. $12.50.

ENCYCLOPEDIA OF CHEMISTRY SUPPLEMENT. By George L. Clark and G. G. Hawley. Reinhold. $10.

NUMERICAL MATHEMATICAL ANALYSIS, 4th ed. By James B. Scarborough. Johns Hopkins. $6.

LETTERS:



No Laughing-Gas Matter

Sir:

On p. 58 of your July 28 issue, I was puzzled by the frequent references to "nitrous" oxide in your review of Kuhlmann's new nitric acid process.

There was no sign of N_2O in the relevant equation; all the evidence indicated that nitric oxide, NO, was being discussed. I believe that the reader should substitute "nitric" for "nitrous" throughout.

A. T. WILLIAMSON
Canadian Industries Ltd.
McMasterville, Que.

► *Mr. Williamson is entirely correct. Our editor must have been temporarily under the influence of laughing gas (nitrous oxide).*—ED.

Today's Job Market

Sir:

Your Aug. 25 article, "Nationwide Job Pools Place Professionals" (pp. 133-134), whatever may have been its purpose, fails totally to picture the current employment situation among chemical engineers. Your mention of (October 1957) some 7,000 unfilled professional and managerial job openings simply has little meaning today.

Using myself as a typical unemployed job-seeker, I have since

PRO & CON

C. H. CHILTON

May 15 made a total of 257 contacts, including 165 letter-resume applications to possible employers. Total yield to date: two interview invitations, no job offers. This extreme buyers' market in technically trained bodies promises no good for our profession and should not be misrepresented or naively ignored.

Wouldn't it have been more meaningful to have printed more timely, pertinent statistics, with perhaps some analysis and forecast for the future? It would have been in keeping with the remainder of your valuable magazine.

M. A. SHELLENBARGER
Wilmington, Del.

Protect the P.E.!

Sir:

I fear you dealt, if not too harshly, at least too unsympathetically with Ralph J. Winters, who did so nobly protest (*Chem. Eng.*, Aug. 11, p. 186) when you docked the precious appendage "P.E." from the signature of Mr. Malmsten.

Would that your heart, like mine, bled profusely for those who rightly demand titular recognition. It would be far better for you to steal from the tender Sunday school tot the bright gold star he is proudly bearing home to his Mummy.

But let us not be satisfied with mere words. I propose the following compound action to remedy the grievous situation:

- Let Congress quickly pass and let Mr. Eisenhower sign a law inflicting a $10,000 fine, or ten years in the hoosegow, or both, upon any adult who willfully ignores, in speech or in writing, a title properly bestowed upon the holder by any accredited educational institution or established official body.
- Tattoo the granted title, in suitably embellished letters, upon the forehead of the recipient, so that all who gaze upon him shall immediately be aware of the dignitary they face. (*Continued*)

PRO & CON . . .

• Authorize and require the title-bearer to wear on the seat of his pants a regal purple patch with his title embroidered thereon in letters of gold, so that persons who approach him from the rear shall likewise be aware of the sacred presence.

As an interim measure I suggest starting a Society for the Prevention of Cruelty to Title-Holders (SPCTH), and I trust you will deign to be counted with me among the charter members thereof.

JOHN E. VISCARDI
White Plains, N. Y.

Con: Eternal Secrets

Sir:

In your *Chementator* item, "Court holds trade secrets sacrosanct" (June 2, p. 43), use of the word "forever" is rather disturbing.

Patents at least have a time limitation. What makes employee contracts so binding?

L. C. CURLEY
Detroit, Mich.

▶ *Key statement in our story was, "The judge's decision apparently establishes trade secrets as a matter of common law. This means that, even without an employment contract, unauthorized use of trade secrets is just as wrong as misappropriation of money or any other private property."*

We took no stand in our news story as to whether or not we agreed with the judge. But the comments we have received from readers indicate that most of them, like Mr. Curley, are disturbed by Judge Christenson's decision.—ED.

(*Continued on p.* 194)

One of Claymont's multi-torch automatic flame-cutters.

by d'Arazien

Main feature of the Claymont story is integration. For instance, consider one phase of our operation—the new Fabrication Shop. First, steel from Claymont's own open hearth is formed into plate on Claymont's own rolling mills and sent to the Fabrication Shop. Here, modern equipment welds, shears, presses, rolls, cuts or machines the plate to produce fabricated products for many industries.

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provides the answers to
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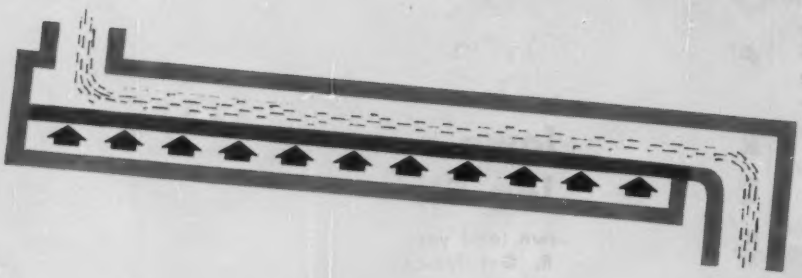

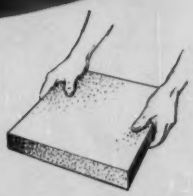

The special porous plate is exclusive with KENNEDY AIR-FLOAT. It is strong, resistant to abrasion and temperature and has a smooth surface texture.

Sections are ruggedly designed, formed on modern production equipment and completely assembled before shipment.

Q. How does AIR-FLOAT work?

A. *The dry material to be conveyed is fed on to a smooth, rigid, porous plate through which low pressure air continuously diffuses. Because the conveyor is inclined about 6 to 8°, the aerated material flows by gravity.*

Q. What distinguishes the KENNEDY AIR-FLOAT from other air-gravity conveyors?

A. *Primarily, the special porous plate. Also the casing is of heavier construction, flanged and channeled for greater rigidity.*

Q. How is this special plate better than other porous media?

A. *The AIR-FLOAT porous plate has literally millions of tiny pores through which the air diffuses uniformly for thorough aeration of the conveyed material. The plate is thicker, stronger, temperature- and wear-resistant, and has a very smooth surface texture.*

Q. How does this improve conveying?

A. *AIR-FLOAT has a much higher capacity than competitive air-gravity conveyors. Blind spots are eliminated and the angle of inclination is less critical.*

Q. What about maintenance?

A. *The KENNEDY AIR-FLOAT is the nearest thing to a completely maintenance-free conveyor that has ever been devised.*

Q. Can turns be made?

A. *Direction changes up to 45° are made with standard pieces. These can be combined for greater angles.*

Q. Are accessories available?

A. *Yes. End and side discharge boxes, splitters, control gates, transitions, bin extractors and required blowers can be provided.*

Q. Have KENNEDY AIR-FLOAT Conveyors been fully tested and proven?

A. *Yes. For more than 12 years AIR-FLOAT Conveyors have been successfully used in KENNEDY-designed cement and lime plants. With this background of experience, KENNEDY is now making AIR-FLOAT available to industry, mass producing it to sell at competitive prices.*

For more information on AIR-FLOAT, ask for Bulletin 58-K.

KVS

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405 PARK AVENUE, NEW YORK 22, N.Y. • FACTORY: DANVILLE, PA.

PRO & CON . . .

Con: Economic Pitfalls

Sir:

In connection with two articles in your July 28 issue, I believe it desirable to warn your readers of limitations in their application.

First, Jelen's article on the use of capitalized cost evaluations (pp. 116-118) omits consideration of profits tax. Because the fictitious capital amount resulting from the capitalization operation may be relatively large, the tax credit on depreciation may be sufficient to reverse completely a decision made without tax consideration.

Second, Lammers' article on the use of continuous compounding (p. 126) should also include a word regarding its application. The variation of $(1 + i)^n$ from e^{in} (where n is a discrete integer in the first form as usually employed in finance considerations) can be quite large, even at reasonable values of i and n.

For example, at $n = 10$ years and $i = 20\%$ (which is not a rare combination in profitability comparisons), the discrete form for the factor $(1 + i)^n$ has a value of 6.192, whereas e^{in} is 7.389, or an increase of about 19%.

Continuous compounding has certain advantages mathematically in dealing with interest. However, it should be employed with full knowledge of its possible variation from the numbers that management has been trained to think about.

H. E. SCHWEYER
University of Florida
Gainesville, Fla.

Butyl Alcohol Producers

Sir:

In your recent review of the solvents picture (Aug. 11, pp. 90-92) you stated that Carbide was the only producer of normal butyl alcohol during the greater part of last year.

What was Celanese doing all this time?

AL BUTYL
New York, N. Y.

► *Celanese Corp. of America informs us it has been in continuous production of synthetic normal butyl alcohol for the past several years. We apologize for our inaccurate and misleading statement.* —ED.

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24-25
*U. S. Steel, Amer. Bridge Div.

Halofluorocarbon.....Products for corrosion control & contamination prevention . . . for critical equipment that must function under difficulty. Technical literature.
202B Minnesota Mining & Mfg. Co.

Insulating Cement.....Super "66" applies to any equipment, cold or hot. Effective up to 1800F. and contains a special rust inhibitive which prevents corrosion.
88 *Eagle-Picher Co.

Lead.....is one of the most efficient & economical protection materials against many acids. The Lead Handbook for the Chemical Process Industries is offered. Bul. 162.
R205
*Federated Metals Div. of Asarco

* From advertisement, this issue

PROPOSALS SOLICITED FOR LEASE OF DEPARTMENT OF THE ARMY INDUSTRIAL FACILITIES

All or portions of the above installations are available for use for commercial purposes. Possible uses are unlimited.

Facilities: Oleum plants (sulphuric acid); nitric acid; acid concentration; ether still; nitrocellulose; various explosive manufacturing; organic chemical manufacturing; steel foundries; heavy and light manufacturing; loading and assembling; offices; warehouses; power plants; storage tanks; many other facilities.

Transportation: Rail and highway facilities are available to these installations, including intra-plant rail and road systems.

Utilities: All necessary utilities are available.

Labor: There is a surplus of both skilled and unskilled labor in the immediate vicinity of most plants.

Detailed information, arrangements for inspections, invitations for proposals and sample form of lease may be obtained from the U. S. Army Division Engineer having jurisdiction over the area in which you are interested. The addresses of the Divisions Engineers are:

MISSOURI RIVER
PO Box 1216
Omaha, Nebr.

OHIO RIVER
PO Box 1159
Cincinnati, Ohio

NORTH ATLANTIC
90 Church St.
New York 7, N. Y.

SOUTH ATLANTIC
PO Box 1889
Atlanta, Georgia

NORTH CENTRAL
536 So. Clark St.
Chicago 5, Ill.

SOUTH PACIFIC
PO Box 3339
Rincon Annex
San Francisco, Calif.

SOUTHWESTERN: 1114 Commerce St., Dallas, Texas

MISSOURI RIVER
1. Cornhusker Ordnance Plant, Grand Island, Nebr.
2. Iowa Ordnance Plant, Burlington, Iowa
3. Kansas Ordnance Plant, Parsons, Kansas
4. Lake City Arsenal, Independence, Mo.
5. Nebraska Ordnance Plant, Wahoo, Nebr.
6. Rocky Mountain Arsenal, Denver, Col.
7. St. Louis Ordnance Plant, St. Louis, Mo.
8. St. Louis Ordnance Steel Foundry, St. Louis, Mo.
9. Sunflower Ordnance Works, Lawrence, Kansas

NORTH ATLANTIC
1. Birdsboro Ordnance Steel Foundry, Birdsboro, Pa.
2. Burlington Ordnance Plant, Burlington, N. J.
3. Edgewood Arsenal, Edgewood, Md.
4. Ordnance Assembly Plant, Edgewood, Md.
5. Radford Arsenal, Radford, Va.

NORTH CENTRAL
1. Badger Ordnance Works, Baraboo, Wisc.
2. East Chicago Ordnance Steel Fdy., East Chicago, Ind.
3. Joliet Arsenal, Joliet, Ill.
4. Kingsbury Ordnance Plant, La Porte, Ind.
5. Twin Cities Arsenal, New Brighton, Minn.
6. Wabash River Ordnance Works, Newport, Ind.

OHIO RIVER
1. Coraopolis Ordnance Steel Foundry, Coraopolis, Pa.
2. Indiana Arsenal, Charlestown, Ind.
3. Jefferson Proving Ground, Madison, Ind.
4. Lima Ordnance Steel Foundry, Lima, Ohio
5. Marshall Plant, New Martinsville, W. Va.
6. Ravenna Arsenal, Apco, Ohio
7. Ridgewood Ordnance Plant, Cincinnati, Ohio

SOUTH ATLANTIC
1. Alabama Ordnance Works, Childersburg, Ala.
2. Holston Ordnance Works, Kingsport, Tenn.
3. Milan Arsenal, Milan, Tenn.
4. Phosphate Development Works, Sheffield, Ala.
5. Volunteer Ordnance Works, Tyner, Tenn.

SOUTH PACIFIC
1. Pacific Ordnance Steel Foundry, Pittsburg, Calif.
2. Riverbank Ordnance Plant, Riverbank, Calif.

SOUTHWESTERN
1. Lone Star Ordnance Plant, Texarkana, Texas
2. Longhorn Ordnance Works, Karnack, Texas
3. Louisiana Ordnance Plant, Shreveport, La.
4. Oklahoma Ordnance Works, Pryor, Okla.
5. Pantex Ordnance Plant, Amarillo, Texas

CORPS OF ENGINEERS, U.S. ARMY

LITERATURE . . .

Paint.....3 p. paint selection check chart suggests paints for a variety of special industrial condition under headings: metal, interiors, exteriors, floors.
204A Wilbur & Williams Co.

Platinum Salts.....A complete list of platinum and platinum group salts and solutions is available on request. Other products include stainless steel & nickel tubing.
R173 *J. Bishop & Co.

Protective Coating.....Hypalon, modified with phenolic and epoxy is useful for tank linings for 73% caustic, and for steel protection against oxidizers.
204B Wisconsin Protective

Resins, Fluorocarbon.....Pipe lined with Teflon TFE resins minimize maintenance & downtime in chemical services. It won't shatter under vibration. Information available.
29 *E. I. du Pont de Nemours & Co.

Stainless Steel.....Booklet illustrates the place of stainless steel in the chemical process industries. Tables of comparative steel properties and corrosion data.
204C Allegheny Ludlum

Synthetic Rubbers....."Elastomers in Industry" gives information about the properties & many industrial uses of neoprene and Hypalon. The right product for your application.
22-23 *E. I. du Pont de Nemours & Co.

Titanium.....available now for sound high-quality castings which are resistant to many corrosive environments. Booklet gives properties & applications of titanium.
8-9 *E. I. du Pont

Wire Cloth.....is available in all standard widths, all meshes, all commercial metals . . . a complete line even up to 400 mesh cloth. Answers to any problems.
176 *Newark Wire Cloth Co.

Electrical & Mechanical

Bonded Pistons.....on pneumatic vibrators bring you lower precipitator maintenance & operating costs. Complete information on the "K-30" is available.
67 *Koppers Company, Inc.

Cutters, Knife.....Bulletin App. 216 gives details on designs, sizes and speeds of the 700 series. Main bearings are available in different types.
204D Taylor, Stiles & Co.

Governor.....Bulletin 1047 describes the SLDG governor designed especially for steam-driven reciprocating pumps or for pumps driven by steam turbines.
204E Blaw-Knox

Gyrol Fluid Drive.....answers virtually every power-transmission need involving adjustable-speed drive. Complete details on type VS, Class 2 & other types is offered.
78 *Amer. Standard, Amer. Blower Div.

Lubrication System.....An exclusive feature of these motors is Lubriflush. Old grease is completely flushed out as new grease is forced in. Full information in bulletin.
41 *U. S. Electrical Motors Inc.

* From advertisement, this issue

LITERATURE . . .

Microwave Oscillator.....A new tool for applications in microwave spectroscopy aids detection of free radicalsatomic analysis and measurement of dipole moments.
207A Laboratory For Electronics

Motors.....New illustrated booklet gives design & special features of chemical, explosion proof & totally enclosed fan cooled motors. All 3 available in frame sizes 56 thru 680.
207B *Marathon Electric Co.

Motors & Generators.....specially built for all atmospheric & hazardous conditions in chemical plants. Bulletin SB-185 gives complete factual information.
34 *Marathon Electric Mfg. Corp.

Motors, Open.....Super-Seal is completely unaffected by moisture, dust, dirt, oil, acids & alkalis. Information available on this & the Silco-Flex.
55 *Allis-Chalmers

Starters, Motor.....eliminates any possibility of heater misalignment. Bulletin SM-275 gives complete story on starters with one-piece thermal overload relays.
101 *Square D Company

Handling & Packaging

Air Hoists.....This fire-safe air hoist easily handles loaded filter plates. Also, provide easily controlled speed for a swift, steady lift. Bul. 80.
201 *Gardner-Denver Co.

Blending Scale.....A blending scale for free-running materials automatically receives, weighs and records granular materials of up to ¼ in. diameter.
207C Richardson Scale Co.

Conveyor Components.....Recently introduced screw conveyor components reduce power demands and maintenance delays. They include conveyor screws, hangers, etc. Folder 2489.
12 *Link-Belt Co.

Conveyor Elevators.....Brochure shows sanitary construction features including cantilever design. Also illustrates buckets, pulleys. Dimensions and capacities.
207D Bucket Elevator Co.

Conveyors, High Temperature.....feature heavy conveying troughs, replaceable trough sections & heat protected drive. Full information is available.
103 Carrier Conveyor Corp.

Containers, Chemical.....Stainless steel acid containers that build a safe, compact stack. Low tare weight reduces transportation costs. Hackney Drum & Barrel Catalog offered.
13 *Pressed Steel Tank Co.

Elevator, Vertical Screw.....The Rotor-Lift elevates & conveys bulk chemicals. Handles capacities up to 6,000 cu. ft. per hr. Engineering catalog is available.
R218
*Southwestern Supply & Machine

Loading Arm, Barge.....saves on line handling injuries, dock clutter, lengthy hookup time, hose bursts & replacement costs. Illustrated literature available.
111 *Chiksan Co.

* From advertisement, this issue

LITERATURE . . .

Portable Bag Closer.....Requires no installation, supports or plant space. Handles textile & paper bags. Complete Catalog File of bag-closing equipment offered.
208A Dave Fischbein Co.

Tanks.....in vertical & horizontal styles for a wide range of applications. Bul. 574 contains 12-pages of specifications plus facts about weather-proof tanks.
188 *The Day Co.

Heating & Cooling

Boilers.....available in 19 sizes, 130 models, 15 to 600 hp . . . steam or hot water, gas, oil, or combination oil/gas fired. Facts on the self-contained boiler offered.
170 *Cleaver-Brooks Co.

Generators, Steam.....features controlled circulation & balanced feed, a principle of using a continuous single pass tube. Produces steam in 3 minutes, from a cold start.
184 *Clayton Mfg. Co.

Heat Exchanger.....Paracoil self-cleaning eliminates need to stop processing for cleaning purposes. Gives process plants increased and better heat transfer. Bul. 1000.
R229 *Davis Engineering Corp.

Heat Exchangers.....The Cross-Bore is immune to thermal shock, accommodates working pressures to 200 psi at temp. to 340 F., & available in 14 standard capacities. Bulletin.
172 *Falls Industries Inc.

Heat Exchanger.....Heat is removed from your process at the rate of imput, giving precisely the temperature you require & assuring quality of product. Bul. 132.
TL185 *Niagara Blower Co.

Packaged Firing Units.....Capacities of standard units range from 200 to 830 boiler horsepower. Details, specifications, illustrations & dimensions in Bul. 28.
R219 *National Airoil Burner Co.

Preheater.....For details on air preheaters and information on potential fuel economy, a factual article is available. Slagging is reduced & cuts boiler downtime.
37 *The Air Preheater Corp.

Vaporizers.....both packaged & field erected, can be outfitted for heating with oil, gas, waste heat or special fuel in outdoor & indoor installations. Bul. "DV".
212 *Union Iron Works

Instruments & Controls

Chromatograph, Gas.....Instrument for monitoring multiple components in a complex process stream. Detailed instrument specifications in data file P-1-14.
61 *Beckman Instruments, Inc.

Computers, Electronic.....LGP-30 is easy to operate, plugs into any regular wall outlet and is completely mobile. Detailed information & specifications offered.
94 *Royal McBee Corp.

* From advertisement, this issue

LITERATURE . . .

Computer, Liquid.....Horizontal tank content indicator is offered. It insures accurate inventories & helps you plan more effecient & economical storage.
105 *Modern Welding Co.

Controls.....Self-powered automatic temperature regulators have special advantages such as no compressed air or electrical wiring required. A 10-page bulletin gives details.
42B *Sarco Company, Inc.

Controls, Liquid.....Meters & accessories offer complete systems for every type of liquid control. Complete information illustrating the types of systems is offered.
71 Bowser, Inc.

Controller.....Pyr-O-Volt is an accurate instrument for reliable stepless control of saturable reactors, r.f. generators and other power amplifiers. Details available.
16-17 Minneapolis-Honeywell

Gages.....available in a variety of materials & special designs, to meet all practical requirements for measuring & observing liquids. Complete line in Catalog 36.
190 Penberthy Mfg. Co.

Gage Illuminator.....The new EPL-56 model gives 3 times the illumination & 3 times the bulb life. Data Unit on process gage illuminators is offered.
L205 *Jerguson Gage & Valve Co.

Instruments.....Pneumatic, electronic, miniature telemeters & recording gauges ... all in a planned line. Technical data is offered on the miniature instruments.
10-11 *Bristol Company

Instruments, Control.....Choose from four controller types ... that include magnetic modulation. Get the facts on their proved performance & installation.
180 Barber-Colman Co.

Meters, Liquid.....Designs to measure most anything that flows ... including all stainless steel meters for corrosive liquids. Full details on meters & accessories.
87 *Rockwell Mfg. Co.

Meter Tubes.....New 20-page catalog details features and specifications of flow-measurement meter tubes. Also specifications on manufacturer's orifice flange.
209A Daniel Orifice Fitting

Miniature Instruments.....Publication 12757 describe the specifications for the manufacturer's line of plastic-door miniature recorders and controllers.
209B Fischer & Porter

Recorder.....Transcope plug-in provides a complete cascade system. Gives continuous 30 day record. The unique set point transmitter allows continuous control.
30-31 *Taylor Instrument Co.

Thermometers.....Bimetal thermometers feature a dampening bearing above the bimetal element that makes them extra resistant to shock & vibration.
92a Rochester Mfg. Co.

Timing Systems.....Brochure depicts manufacturer's products, facilities and staff capabilities. Products for observing and recording reactions and events accurately.
209C Edgerton, Gereshausen, Grier

*From advertisement, this issue

LITERATURE . . .

Pipe, Fittings, Valves

Bellows, Stainless Steel.....for toughest airborne applications. In single or multiple ply, in a wide range of sizes & shapes, including braid covered types. Bul. TC-1400.
187 *Robertshaw-Fulton Controls.

Compensators.....high - pressure, heavyduty expansion compensators cost much less per inch of stroke than any other method of absorbing pipe. Design & cost data offered.
182 *Flexonics Corp.

Fittings.....The low carbon C-1025 steel insures optimum weldability, & strength. Information about 1025 steel & your commercial forging requirements is offered.
214 *H. K. Porter Co., Inc.

Fittings.....Usco Weld features fast, easy assembly, automatic alignment of pipe & fittings & strong joint interference. Details available on Usco Weld & plastic pipe & fittings.
163 *U. S. Rubber

Fittings, Welding.....any type of special fittings made from plate to the most rigid specification. Closer tolerances & quality control. Bul. 5801 for details.
89 *Midwest Piping Co.

Joints, Expansion.....circular or toroidal expansion joint provides lower operating stress & is suitable for use at high temperature. Data is available.
37 *Zallea Brothers

Nozzles.....Lightweight, precision built steel spray nozzles feed just the right amount of fuel into combustion chamber. Complete information is available.
196 *Spray Engineering Co.

Packings.....Teflon packings last longer under corrosive conditions. Ideal for sealing pump & other rotating shafts against acid, caustics, aromatics, etc. Bul. CP552.
L215
*Chemical & Power Products, Inc.

Packings....Lattice-Braid Teflon packings provide tight seal up to 100 psi pressure. Folder AD-131 gives details on 2000 different styles of packings, gaskets & seals.
14-15 *The Garlock Packing Co.

Pipe.....Flexpipe connectors come in convenient sizes & are sold by leading distributors. Detailed information on service application & samples are available.
159 *The American Brass Co.

Pipe.....Bulletin TS-1A gives complete details on fluoroflex-T pipe. It resists corrosion, and can handle hydrofluoric acid with complete safety & no maintenance problems.
107 *Resistoflex Corp.

Pipe, Polyvinyl.....for a variety of uses in the chemical industry. Resistant to many chemicals, including acids, alkalies, salt solutions & alcohol. Bul. 24.
112 *U. S. Steel, National Tube Div.

Pipe, Saran-lined.....fittings, valves and pumps are available for systems operating from vacuum to 300 psi, & from well below zero of 200°F. Complete details on request.
95 *Dow Chemical Co.

*From advertisement, this issue

LITERATURE . . .

Tees.....lined with pure, white Teflon, ⅛" thick. Lining has no welds. Solve corrosion & contamination problems. Details outlined in Bulletin K-57-A.
28 *John L. Dore Co.

Tubing.....send for a copy of the new Trent 48-page tubing handbook. Gives details on applications, special features and uniformity of this tubing.
80 *Trent Tube Co.

Tubing & Pipe, Stainless.....Complete data on the many analyses of welded stainless tubing & pipe is outlined in Bulletin T. D. 120. Features corrosion control.
104 *Carpenter Steel Company

Tubing, Polyethylene.....Special types of cabled instrument tubing to meet specific needs. Bulletin 458-H.
RL213 *Crescent Insulated Wire & Cable Co.

Unions, Tri-Lug.....Model 603A offers strength, interchangeability & corrosion-resistance. Complete information and prices on these unions is available.
125 *Rockwood Sprinkler Co.

Valves.....Alloy construction gives ease of operation & low maintenance. Folder, "Valves & Fittings in the Pulp & Paper Industry" gives details on the complete line.
114 *Cooper Alloy Corp.

Valves.....Cupola back pressure valve is also adapted to air lines in industrial plants where weight is a factor. Installation, sizes etc. in detail... see Bulletin 10000.
211A Norwalk Valve Company

Valves.....Nine new flanged end forged steel Gate, Globe & Check valves are available. Literature on sizes, pressures and types of the complete line is offered.
128 *Henry Vogt Machine Co.

Valves, Control.....Super 70 diaphragm valves are available in either clamp ring, float ring, sealed bonnet or flanged-gasketed body closures. Information offered.
79 *Black, Sivalls & Bryson, Inc.

Valves, Diaphragm.....Horizontal & vertical types provide positive check against reverse flow of gas or air. Complete data contained in Bulletin 2000.
211B Norwalk Valve Co.

Valves, Drain.....cannot clog up. Designed so that in the closed position the piston or ram extends up into the tank. In open position, full flow assured. Catalog.
R183 *Strahman Valves, Inc.

Valves & Fittings, PVC.....are designed to regulate the flow of alkalies, acids, & similar corrosive fluids. Booklet describes mechanical & thermal properties, sizes, etc.
169 *Walworth

Valves, Gate.....Exceptional performance, longer valve life, less maintenance and easier operation. Get all the details on types & sizes in catalog 57.
194 *Darling Valve & Mfg. Co.

Valves, Needle.....for finer regulation of water, oil or gas. Offers a maximum working pressure of 10,000 PSI. New catalog gives complete details.
TL213 *Marsh Instruments Co.

*From advertisement, this issue

LITERATURE . . .

Valves, Safety Relief.....features the Eductor Tube which efficiently removes pressure from the closed bonnet. Complete details contained in Catalog 1900.
96 *Manning, Maxwell & Moore, Inc.

Valves, Stainless Steel.....designed for viscous liquids & other fluids difficult to move at room temperature. Other designs for specific applications.
117 *Alloy Steel Products Co.

Process Equipment

Agitators, Portable.....Nettco drip-proof construction prevents oil-in-mix contamination. Available in high speed & medium speed, 1/6 to ¾ HP. Bul. 581.
228 *New England Tank & Tower Co.

Blenders.....Rotary blenders start 4-way blending while charging, continue it during discharge, thus producing highly intimate, even blends of dry & semi-dry materials.
L218 *Sturtevant Mill Co.

Catalytic Purifier.....is combined with an automatically operated drying unit to provide oxygen-free hydrogen that is ideally pure & dry. Descriptive literature offered.
99 *Engelhard Industries, Inc.

Centrifugal.....The Tornado is fully automatic, gives you 24-hr. production. Also available in manual & semi-automatic models. Detailed information offered.
208 *The New Fletcher Works, Inc.

Centrifugals.....Catalog CE-58 gives complete information on size, type and capacities of "Ter Meer" centrifugals. Designs for every process in the chemical industry.
115 *Baker Perkins, Inc.

Centrifugals.....Reineveld automatic centrifuges used for dewatering & washing of crystalline solids & for separation & clarification of fine amorphous slurries. Bul. 356.
TL195 *Heyl & Patterson, Inc.

Centrifugal Process.....for continuous acidulation process for tall oil production. Detailed information on this process is available, plus ways of producing quality product.
6-7 *The De Laval Separator Co.

Conveyor Dryer.....offers increased drying capacity per square foot of surface, easier apron cleaning, & improved uniformity of dried product. Literature available.
124 *National Drying Mach. Co.

Cooling Towers.....If water conservation is in your development plans, you will find it profitable to investigate Marlith Bulletin M-58. Installation is Fungus-Proof.
97 *The Marley Company

Crystallizers.....assure you operating advantages that include; lower centrifuging costs, less processing, dust elimination, minimum caking etc. Bul. CE-57.
39 *Struthers Wells Corp.

Dryer, Air.....remove unwanted moisture from compressed air. End freezups, corrosion & clogging due to water in the air lines. Complete information in Bul. 223B.
91 *Pittsburgh Lectrodryer Div.

* From advertisement, this issue

LITERATURE . . .

Dryers.....You can test the drying or reacting of your materials in the continuous atmospheric rotary or fluidized bed dryers. Other equipment available for your needs.
171 *General Amer. Trans. Corp.

Dryers.....Hydryers are ideal for drying synthesis gas, instrument air & many other compressed gases. Illustrated bulletin details the functions & exclusive features.
210 *J. F. Pritchard & Co.

Dryers, Rotating Vacuum.....is available in six sizes and include provisions for steam or hot water heating. Complete information & application data available.
181 *F. J. Stokes Corp.

Dust Collection Systems.....Booklet, "The Collection & Recovery of Industrial Dusts," gives information on Cyclone, "SF" Electric Precipitator & Precipitator-Cyclone.
216 *Buell Engineering Co.

Dust Collectors.....Miniature cyclone tubes, cast of white iron, provide ultra-hard, cling-free, self-cleaning surface for maximum material recovery. Bul. D-584.
TL183 *Dustex Corp.

Dust Controls.....An efficient dust collecting system, scientifically planned, designed & constructed. Cloth filters bag collectors offer maximum efficiency. Bul. 922.
85 *Pangborn Corp.

Ejectors, Steam Jet.....Descriptive bulletins on single-stage, multi-stage & corrosion-resisting types of steam ejectors are available. Handle all applications.
186 *Elliott Company

Feeders, Airlock.....available in standard duty, heavy duty, & blow-thru types. Booklet P-58, "How to Select A Rotary Airlock Feeder", is offered.
BL183 *Prater Pulverizer Co.

Feeding Systems.....Model 32 continuous loss-in-weight system features, accuracy, automatic control, & flexibility. Range from 10:1 up to 50:1. Details in bulletin
174 *Omega Machine Co.

Filters.....FEinc precoat filter is designed for trouble-free operation, dryer cake discharge & high clarity of effluent. Specific recommendations for your problems.
93 *American Machine & Metals.

Filters.....A new catalog is offered with complete details on Fulflo filters. They provide true depth filtration at minimum pressure drop for liquid chemicals, etc.
1 *Commercial Filters Corp.

Filters.....Designed for all vacuum filter applications. Bul. KSI-2-3 gives detailed information & illustrations plus specifications.
214A Komline-Sanderson Engr. Corp.

Filter Aid.....Solka-Floc is highly purified, finely divided cellulose. Adsorbs many metals such as iron, copper, other impurities. It makes a stable pre-coat.
226 *Brown Company

Filter, Gas.....removes all fine dust & scale from gas. Composed of removable filter material in tricurled hair or spun glass wool. Bulletin 9200 for details.
214B Norwalk Valve Co.

* From advertisement, this issue

LITERATURE . . .

Filters, Water.....Where high quality process water is needed, diatomite filters provide an effluent second only to distilled water. Bul. 651 & Bul. 909 give details.
178 *R. P. Adams Co., Inc.

Ion Exchange.....Technical reprint T-159 tells how each of ten methods of ion exchange regeneration works, and what equipment and controls are needed.
215A Graver Water Conditioning

Mills, Grinding.....built to meet specified conditions for wet or dry grinding, in sizes 6 ft to 13 ft in diameter & up to 50 ft. in length. Complete line in Bul. 232.
116 *Nordberg Mfg. Co.

Mixers.....The complete line of fluid mixers range from fixed-mounted 40 H. P. turbines & heavy-duty propeller mixers to lightweight portables. Handbook offered.
202a *Eastern Industries, Inc.

Mixers.....You'll find a wealth of information on fluid mixing in helpful bulletins describing Lightnin Mixers. These mixers adapt to changes in your process.
232 *Mixing Equipment Co.

Mixers.....A three-way knead, smearing, spatulate action coats one material with another. Bulletin on Mulling for the chemical & process industry is offered.
126 *National Engineering Co.

Mixers.....Important design advantages include, extra large, heavy duty bearings throughout & extra long out-ut shaft bearing span. Cat. A-27 contains complete information.
175 *Philadelphia Gear Corp.

Mixers.....built in capacities to suit any production requirement, with ready adaptability to materials handling systems. Information available.
81 *Read Standard

Mixers, Portable.....for high speed, slow speed and intermediate. Details of production and laboratory models in Bulletin 74B. Top entering mixers also available.
168 International Engineering, Inc.

Processor.....For chemicals, pharmaceuticals or other temperature-sensitive products, Turba-Film retains essential properties & desired qualities of product produced.
59 *Rodney Hunt Machine Co.

Separation, Air.....Bulletin S-55 gives specifications for a centrifugal separator; another reprint presents formulas applicable to air separation problems.
215B Universal Road Machinery

Separator, Centrifugal.....Get the true facts & comparative figures on the continuous solid bowl centrifugal separator. For your solid-liquid separations.
4 *Bird Machine Co.

Sifters.....The super active ball cleaning device provides rebound points in each ball compartment, assuring fast, thorough sifting of your product. New ro-ball bulletin.
177 *The J. H. Day Co.

Tower Internals.....Booklet entitled "Fractionation Column Internals" describes manufacturers line of trays, supports and attachment clamps. Services discussed.
215C Hendrick Mfg. Co.

* From advertisement, this issue

LITERATURE . . .

Pumps, Blowers, Compressors

Compressor.....The CRX carbon piston compressor does not require oil or water lubrication. Learn the details from Bulletin CRC-10. All types of compressors available.
200 *Gardner-Denver Co.

Compressors....Electric-Driven, Steam-Driven, Gas-Engine compressors and Centrifugal compressors are available. Form 3132A gives information on process compressors.
49 *Ingersoll-Rand

Compressors, Rotary.....There are twelve sizes of two-stage Ro-Flo compressors to choose from. For complete information see bulletins 16B8244 and 16B8126
119 *Allis-Chalmers

Compressor, Rotary.....New illustrated bulletin ACO 100.1 gives typical performance data on the axial-flow unit that combines advantages of reciprocating & centrifugal models.
231 Fairbanks-Morse & Co.

Pumps.....The H Durcopumps are built with capacities from ½ to 3500 gpm, & with heads to 345'. Available in 12 standard corrosion resisting alloys.
161 *The Duriron Co.

Pumps.....Full information about different models is available. All pumps with built-in safety margin to assure maximum efficiency under most severe use.
76a *Fairbanks-Morse & Co.

Pumps.....Whatever your pumping needs, vertical pumps for molten chemicals, horizontal pumps for black liquor, caustic, etc. Write for bulletins V-837 & C-355.
L209 *Taber Pump Co.

Pumps.....There are 750 cataloged models in 20 sizes, with additional thousands of specially built pumps available. Catalogs Section BC and CC give details.
BL195 *Viking Pump Co.

Pumps.....The SESC line offers 120 different sizes with open or closed impellers with capacities up to 2700 GPM & heads to 550 ft. Details in Bul. W-300-B48.
26-27 *Worthington Corp.

Pumps, High Temperature.....designed especially for handling high temperature liquids. Offers hydraulically efficient impeller & casing design. Details offered.
32 Buffalo Forge Co.

Pumps, Process.....The complete range offers all types of chemical process pumps, in all sizes & frames. Bul. EM-79 on "Mechanical Consideration in Pump Design" is offered.
90 *Food Mach. & Chem. Corp.

Ventilator, Power Roof.....features variable pitch V-belt drive & wheel & inlet design for streamlined air flow. Offers simple installation. Details in Bulletin 550.
86 *Clarage Fan Co.

Wearing Rings.....eliminate pump jamming and prolong high efficiency. Give constant pump service. Complete details are available on request.
53 *Allis-Chalmers

*From advertisement, this issue

Highly Intimate Blends in 1 to 2 Minutes

Blends while discharging; No segregation or flotation

Sturtevant Rotary Blenders start 4-way blending while charging, continue it during discharge, thus producing highly intimate, even blends of dry and semi-dry materials – within 3 to 5 minutes of start of charging.

Six *complete* blending cycles per hour are common. And Sturtevant's special action produces no particle reduction, cleavage or attritional heat – is highly effective yet gentle and safe even with explosives.

Receiving

Scoops cascade material as drum rotates. Movement forces material from both ends to middle. Thus blending is 4-way right from start of charging.

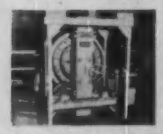
Discharging

Single gate controls charge, discharge. Blending continues throughout discharge phase. Result is no segregation or flotation — highly intimate, even blends.

Self-cleaning, dust-sealed drum; one-man accessibility

Operation of Sturtevant Blenders is self-cleaning – drum interiors are completely dust-sealed. For inspection of all models, one man simply loosens a few lugs to remove manhole cover – quickly and easily.

Nine standard models with capacities to 900 cu. ft.



10 cu. ft. Sturtevant Blender at U.S. Steel Corp.'s new Applied Research Laboratory (Raw Materials Division) in Monroeville, Pa. This unit handles batches up to 500 lbs. — is ideal for pilot work and small runs.

One of four 450 cu. ft. Sturtevant Blenders at Celriver Plant of Celanese Corp. (Rock Hill, N. C.). These large units handle up to 20,000 lbs. batches — have a 9-year record of meeting the most exacting blending requirements.

Fully or semi-automatic, or manually controlled operation

Constructed of carbon steel, stainless steel or Monel metal, Sturtevant Rotary Blenders are engineered to fit each customer's needs – can be supplied with injector sprays and any desired control system.

For more on Sturtevant Blenders, request Bulletin No. 080B. (Bulletins also available on Mixers, Air Separators, Micronizers, Crushers and Grinders.) Write today. STURTEVANT MILL CO., 100 Clayton St., Boston, Mass.

LITERATURE . . .

Services, Processes, Misc.

Bench-Scale Equipment.....a complete integrated line of professionally designed equipment for pressures up to 5000 p.s.i. Detailed information in Bulletin 658.
179 *Autoclave Engineers, Inc.

Construction ..... Surveys, Reports, Appraisals, Process Engineering & Design, Procurement of Equipment & Materials for process industries.
83
*Stone & Webster Engineering Corp.

Cooling System.....The Unitron Semi-Conductor Rectifier can be built in any desired d-c voltage & current rating. Complete information offered on request.
108 *I-T-E Circuit Breaker Co.

Disinfectants.....Manufactured products for promotion of health & sanitation. Research with insecticides, soap, etc. Literature available with complete information.
218A West Disinfecting Co.

Dynel Fabric.....Chemically resistant industrial clothing virtually unaffected by acids & alkalies. Booklet gives effects of reagents on dynel fabric after tests.
167 *Union Carbide Chemicals Co.

Fire Protection Systems....new 44-page manual gives you a comprehensive picture of advanced methods for Special Hazard fire protection, with applications & charts.
36 *Grinnell Co.

Industrial Apparel.....resists punishing acids & chemicals. Complete facts about acid & caustic resistant apparel contained in catalog which is offered.
168 *Worklon, Inc.

LPG Installations.....8 p. bulletin No. 66 illustrates and describes the design features of liquefied petroleum gas plants. Covers product properties and uses.
218B W. C. Holmes & Co. Ltd.

Metallurgy, Chloride.....36 p. brochure, "Chloride Metallurgy", describes physical and chemical properties, uses, reactions of aluminum chloride, and antimony trichloride.
218C Stauffer Chemical Co.

Optical Systems.....Technical skill & complete facilities for highly precise work in optics, mechanics & electronics. Literature offered gives complete information.
R21f *Kollmorgen Optical Corp.

Pulp Chlorination.....9 p. bulletin No. P-1006, "Introduction of Chlorine Gas to Pulp Chlorinating Towers," includes equipment sketches and flow diagrams.
218D Pennsalt Chemicals Corp.

Structures ..... Engineers, fabricators & erection specialist, for the challenge of things to come in the atomic age . . . structures to silhouette major reactor projects.
73 *Chicago Bridge & Iron Co.

Waste Disposal Units.....are custom designed to your specification. Any size or capacity for use in reducing liquid & semi-liquid wastes or obnoxious gases.
TL173 *John Zink Co.

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CHICAGO 11: 520 N. Michigan Ave.
SAN FRANCISCO 4: 68 Post St.

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Manufacturer of Heat Exchangers and Pressure Vessels, located in New Jersey, wants sales representatives in various parts of country. Representatives should have contacts in oil refineries, power plants, chemical plants or marine. RW-8806, Chemical Engineering.

Agents required for Laboratory Hydrocyclone Test Set (Chemical Engineering 11/56). RW-8622. Chemical Engineering.

EMPLOYMENT SERVICES

Salaried Personnel $5,000-$30,000. This nationwide service successful since 1927 finds openings in your field. Sells your abilities; arranges contracts. Present position protected. Write for details—Jira Thayer Jennings, P. O. Box 674, Manchester, Vermont.

Better Positions—$6,000 to $50,000. Want a substantial salary increase, more opportunity or different location? This national 47 year old service connects you with best openings. You pay us only nominal fee for negotiations; this we refund when employer pays placement fee. Present position protected. In complete confidence, write for particulars. R. W. Bixby, Inc., 553 Brisbane Bldg., Buffalo 3, N. Y.

ADDITIONAL EMPLOYMENT OPPORTUNITY ADVERTISEMENT on opposite page

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EQUIPMENT SEARCHLIGHT

CE's Searchlight spots the big bargains in used, resale and rental equipment. Check this issue's listings—most complete in the field—for items you need now.

▶ **Coverage** — National. Equipment and facilities—used, resale and rental—for the process industries. For sale, wanted, for rent.

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BARGAIN BUYS in good REBUILT EQUIPMENT

RECENT ADDITIONS TO FMC's FINE STOCK!

SPARKLER Stainless Steel Filter Model 14-2-4 complete.
PITTSBURGH Lectrodryer Model BWC/500.
Foster Wheeler Continuous Deodorizer.
National Erie Jacketed Extruder; 6" x 66"; Jktd; Strainer Head; Chrome Screw.
Louisville Stainless Rotary Dryer indirect fired; 30" x 28' complete.
3 Sturtevant Rotary Blenders 7' x 40' 125 cu. ft. holding 75 cu. ft. working.
Colton No. 5½ Single Punch Tablet Press.

Louisville Rotary Kiln 41" x 15'; brick lined.
Stainless Lined Rotary Dryer, 50" x 20' with Oil Burner, Combustion Chamber, etc.
Struthers Wells Stainless Drum Dryer, 4' x 5'.
Bagley & Sewall Double Drum Dryer, 28" x 60".
Buflovak Dbl. Drum Dryer, 48" x 120" complete.
Hersey Rotary Gas Fired Counter Current Dryer; 5' x 28' complete accessories.
Stokes Rotary Jacketed Dryer, 18" x 8'.
Stokes Impregnator Model 58-24 complete with Condenser, Receiver, and Microvac Pump.
American Dbl. Door Sterilizer; 30" x 48" x 84".
Fort Wayne Sterilizer No. 24A, 5' x 10'4".
Filter Presses in Stainless, Aluminum, Cast Iron and Wood from 7" to 42" complete.
Rotary Cutters by Abbe, Ball & Jewell, Whitin, Leominster, Sprout Waldron, all sizes.
4 Stainless Mikro Pulverizers Model No. 2; other Mikros from Bantam size up to No. 4.
Fitzpatrick Stainless Comminutators; Models D and K, 20 H.P.
Tumbling Batch Mixers; 17 cu. ft., 75, 150 and 300 cu. ft.
Day Hi Speed 3 Roll Mill; 14" x 30" water cooled with 25 HP motor; late model.
3 A. O. Smith Stainless Lined Pressure Tanks; 10' x 18' 7"; 11,000 gal. like new condition.
Blaw Knox Stainless Reactor or Resin Kettle, 7'6" x 7'6"; welded; jacketed; agitated.

Steel Reaction Kettle; 1500 gal.; ASME; 72" x 62"; jacketed; agitated; motorized.
NEW Falcon Stainless Reactor; 125 gal. 30" x 30"; jacketed; agitated; motorized.
A. T. & M. Stainless 60" Centrifugal Extractors; link suspended; center slung; vapor-tite.
Tolhurst 40" center slung, rubber covered Basket & Curb; Monel Plow; 2 speed motor.
Sharples Stainless Super-D-Canter; 10 HP.
Sharples H2 Nozzlejector; 1000 GPH; XPL motor.
Derrco Rotary Vacuum Filter 8' x 3'; nickel contacts.
Feinc S.S. Rotary Vacuum Filter; 5' x 6' complete.
Oliver S.S. Filter No. 50; 8 S.S. Leaves; 60 sq. ft.
Cherry Burrell S.S. Homogenizer or Viscolizer, 1500 gal. 25 HP Motor.
V. D. Anderson "RB" Expeller with Tempering device.
Colton No. 5½ Tablet Press Kux Model 60A Tablet Press Stokes T; Colton 4½ others.
Largest Stock of Baker Perkins Heavy Duty Double Arm Mixers from Lab. size to 300 gal.
Day Cincinnattus Stainless Steel 300 gal. Jacketed Double Arm Mixer; XPL motor.
Lancaster Mix Muller Mixer Type EAG; Bowl size 45⅝"; capacity 5½ cu. ft.
Simpson Mix Muller No. 2; 6' Pan; 25 HP Motor.
Simpson Intensive Mixer Model O Style M; 36" Pan.
Porcelain and Buhrstone Lined Pebble Mills; 30" x 42"; 37" x 48"; 6' x 6'; 8' x 8'.
Patterson Jacketed Ball Mills; 54" x 42" Model DJ.
Sifters and Screens by Day RoBall; Orville Simpson Rotex, Gyro Whip; Patterson, Robinson.

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In Stock for Immediate Shipment
Stainless or Mild Steel
Approved Sanitary; Smooth Interiors
Double Ribbon Mechanism Quickly Removable for Cleaning
Mixes Heavier Load with Less Power
State Your Size — WE HAVE IT

FIRST MACHINERY CORP.

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Komarek-Greaves Briquette Presses 27" x 23" and 20" x 9"
7' x 120' Rotary Kilns
8' x 125' Rotary Kiln
604—24 Stainless Roto-Louvre Dryer
705—24 & 502—16 Roto-Louvre Dryers.
6' x 50', 6' x 30', 6' x 25' Rotary Steam Tube Dryers
5' x 40' Rotary Kiln ⅜" Shell
Jeffrey Hammermills 36" x 24", 24" x 18", 20" x 12", 15" x 8"
25' to 90' Centers Bucket Elevators
750 gal. jktd. Steel Reactor 300 PSI

SEND FOR LIST #658

30" Fletcher Stainless Susp. Cent. m.d.
40" Fletcher Steel Susp. Cent. m.d.
50 gal. jktd. Stainless Reactor 50 PSI
5'3" x 6' Rubber Oliver Precoat Filter
6' x 8' Eimco Steel Rot. Vac. Filter
Sweetland #10 Filter 36 SS Leaves
4' Stainless Ind. 14 leaf Filter
#3036 Raymond 3 roll Hi-Side Mill
#6669 Raymond 6 roll Hi-Side Mill
#5057 Raymond 5 roll Hi-Side Mills
#11 Rotex Screens 20" x 48"
5750 gal. all Stainless Tank
500 gal. Stainless Tanks

HEAT & POWER CO., INC.

CHEMICAL EQUIP'T DIV.
60 East 42nd St., New York 17 N. Y.
Telephone: MUrray Hill 7-5280

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AUTOCLAVES—BLENDERS—COLUMNS
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HOPPERS—MILLS—MIXERS
PRESSES—REACTORS—TANKS

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See Our "Searchlight" Ads
September 22 Issue
October 20 Issue

PERRY EQUIPMENT CORPORATION

1413-21 N. SIXTH STREET
PHILADELPHIA 22, PA.
Phone: POplar 3-3505

EQUIPMENT FOR SALE

Dock boards, magnesium—
one 36" wide, 16' long
one 42" wide, 15' long
Coloreye, Model 500016, Ser. No. 3045 (Instrument Development Lab., Inc.)
Stokes tube filling machine Model #D97-80A
Kent 3-roll lab mill, ¾ hp, 4x8 roller, #54026
Lab baking oven, Lanly 40,000 BTU, max temp 500° F, 32"x52"x62"
Lab alkyd resin unit—36 gal capacity, stainless steel 36"x24"x38"
Storage tanks, steel,
3 only 12'x14' Capacity 11,900 gals
1 only 12'x16' Capacity 12,400 gals
2 only 6½'x32' Capacity 8,023
1 only 6'x16' Capacity 3,315
4 only 7'x25' Capacity 7,000
Varnish kettle, stainless steel with cover—375 gal capacity
Motors ranging from 1/6 hp to 20 hp
Pumps, both 1½" and 2"
Platform scale, Fairbanks Morse, P-2 Model (still crated)

Will accept any reasonable offer.

GENERAL PAINT CORPORATION

2627 Army Street, San Francisco, California
Phone: Mission 8-1904

COMPRESSORS

World's Best Rebuilts

27 CFM	3000 PSI Worth V4A3
70 CFM	1500 PSI 9x8 Norwalk TD93T
110 CFM	3000 PSI Ing. 6C 506W
208 CFM	350 PSI 9-4x9 Ing. ES2
238 CFM	100 PSI 9x9 Ing. ES
321 CFM	125 PSI 10x11 Ing. ES
465 CFM	100 PSI 12x11-1R-ES-1
502 CFM	125 PSI 12x13 Worth HB
583 CFM	100 PSI 15-8¼x12 Ing. XRE
590 CFM	100 PSI 13½-8x8 Penn DE2
676 CFM	100 PSI 15-9¼x12 Worth. & IR
686 CFM	100 PSI 14x13 Ing. ES Worth HB
860 CFM	100 PSI 13-8x7 Joy WN102
1302 CFM	100 PSI 20-12x14 CP-OCE
1721 CFM	125 PSI 23-13x16 CP-OCE
7950 CFM	200 PSI 33-17¾x27 Ing. PREZ4C

Vacuum Pumps (Dry)

AMERICAN AIR COMPRESSOR CORP.

North Bergen, N. J. Union 5-4848

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Liquidations; appraisals our specialty.

Wire us your list today, or phone GA 1-1380

ME MACHINERY AND EQUIPMENT CO.
123 Townsend St. · San Francisco 7, Calif.

LIQUIDATION

Two complete briquetting plants

St. Nicholas, Pa., and Locust Summit, Pa.

4—Ruggles-Coles Class #XA-18 double shell indirect-direct heat rotary dryers, 104" x 70' x ⅝" welded steel outer shell.

4—Komarek-Greaves briquetting presses, 75 HP, 25 tons per hour.

4—Komarek-Greaves vertical Fluxers (paddle mixers), triple shaft, 150 HP.

4—K-G Horiz. Fluxers 41" dia., 50 HP.

4—K-G Pug Mills, 30" dia. x 14'4" long.

8—Tyler Screens, 4' x 8', 4' x 6'.

2—42" wide travelling-screen cooling conveyors, total of 950'.

2—8'6" dia. x 70' long rotary hot air dryers.

4—36" x 24", 24" x 18" Jeffery hammermills, 50 HP, 25 HP.

6—Robinson Size #13 Sawtooth Crushers.

2—Pa. Crusher #C-3-30 hammermills, 60 HP.

20—Welded Steel bins, cone bottom, from 15,000 gallon to 90,000 gallon sizes.

4—Keeler Boilers 200 HP, 160 PSI.

8—16", 18" & 24" trough-belt conveyors, 100', 250', 500' long.

6—36' & 48" apron feeders, 8' long.

8—Bucket elevators, 62' and 90' c-c.

6—500 KVA Transformers.

300—Motors and controls, 1 to 150 HP.

ALSO—Chain hoists, steel pipe, valves, hoppers, blowers, misc. equipment, etc.

BUILDINGS—(2) All steel Buildings 50' wide x 198' long, 60' high under roof trusses, clear span.

REAL ESTATE—7.8 Acres at Locust Summit, Pa. 6.0 Acres at St. Nicholas, Pa.

Served by Reading RR—With Private Tracks
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PERRY EQUIPMENT Corp.
1413-21 N. SIXTH STREET
PHILADELPHIA 22, PA.
Phone: POplar 3-3505

HEAT & POWER CO, Inc.
60 E. 42nd STREET
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Phone: MUrray Hill 7-5280

LOEB OFFERINGS

Autoclave: 50 gal. Struthers-Wells, st. st.
Centrifugals: 12", 17", 20" and 26".
Clarifiers: De Laval and Sharples, st. steel.
Crystallizers: 500 gal. stain. steel, jacketed.
Dryer: Devine 2 x 4' vac. drum, st. steel.
Dryers: Link-Belt Monotube of monel.
Filters: Eimco, Oliver, Sweetland, Alsop, Sparkler, Industrial, Sweetland.
Kettles: St. steel, with and without ag. Dopp 150 gal. dbl. act. agitator.
Labelers: World Bee-Line automatic labeler.
Mills: Mikro Bantam, 2TH and 24". Fitz Comminuting model D, st. st. Day 12 x 32" 2-speed high speed.
Mixers: Dbl. and Sgl. arm sigma blade. Dry Powder, various sizes. Hockmeyer 60 gal. change can.
Mix-Muller Simpson Lab., Porto, #00.
Percolator: Pfaudler 54 x 42" st. st. jack.
Pumps: Rotary, gear, centrif., vacuum.
Pumps: LaBour st. st. 2½" 15 hp. TE.
Tanks: 800 gal. st. st. side agitated.
Vacuum Pan: 42" Harris st. steel.

LOEB
EQUIPMENT SUPPLY CO.
420 WEST SUPERIOR ST. · TELEPHONE SEEley 8-7431 · CHICAGO 22, ILLINOIS

BUY ON TERMS!

SPECIALS FROM OUR STOCK OF OVER 10,000

1—Mill, Sturtevant Model 1½ Ring Roll
2—Expellors, Anderson Super Duo w/Cook
1—Dryer, 8' x 50' Rotary, 1/2" shell
1—Filter, Shriver 12" S.S. 7 pits & frms
3—Disintegrators, Rietz RDH-18, 316 S S
1—Centrifuge, A T & M 42" perf susp bas
1—Mill, 6' x 6' Pebble, with 25 HP mtr
2—Mills, Day 16" x 40" 3 roll lii-speed
1—Reactor, Braun 850 gal nickel lined
2—Mixers, J. H. Day 40 gal Pony, 30 HP
2—Kettles, New Green 60 gal S.S. Mod. D.A.
4—Pumps, Moyno 4" stainless, Style C

For any item you need, wire or phone collect GA 1-1380

MACHINERY AND EQUIPMENT COMPANY
123 Townsend St. · San Francisco 7, California

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24" Round Gyratory Riddles
12" X 6' Single deck Ajax Loveyor
20" X 81" Triple deck Rotex
40" X 84" Double deck Rotex & Roball
3' X 5', 4' X 10' Single deck Tyler Hummer
3' X 10' Double deck Tyler Hummer
42" X 10' Double deck Cedar Rapids
60" X 10' Triple deck Deister "Plato"
60" X 12' Double deck Robbins "Eliptex"

ALL REBUILT AND GUARANTEED IN OUR STOCK

LAWLER COMPANY
Durham Ave. Liberty 9-0245 Metuchen, N. J.

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Stokes 3-DDS2, I-T, I-RD3, 2-B
Baker Perkins 100 gal. S.S. double arm 50 HP jacketed, vacuum, hyd tilt.
Blaw Knox 2 gal. S.S. Autoclave 5000 lb.
50 gal. S.S. Autoclave 2000 lb. press.
Vulcanizer 60 in. x 9 ft. 125 lbs.
Oliver S.S. Pressure Filter.
Sweetland #2 all Stainless.
Stainless Steel Ball Mill.
Aluminum Condenser 350 sq. ft.
1—Aluminum evaporator, Calandria type, never used, 1300 sq. ft. tube area.
1—Baker Perkins 100 gal. double arm steel.
2—Procter & Schwartz tinned drum driers.
Continuous stripping column 2 x 13 steel.

LOUIS SUSSMAN, INC.
800 Wilson Ave. (East of Doremus)
Newark 5, N. J. MI 2-7634

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REBUILT RAILROAD CARS FOR INTERPLANT USE
GONDOLAS • BOX • FLAT
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"FASTER FROM FOSTER"
TESTED & STRUCTURAL **PIPE**
Warehouse Stocks 1/8" thru 48"
Valves, Fittings, and Couplings
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PITTSBURGH 30 · ATLANTA 8 · NEW YORK 7
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Poor Aladdin . . .

The best service at Aladdin's command was rubbing a lamp and WISHING for what he wanted. YOU have "Searchlight" to help you find what you want!

CAN "SEARCHLIGHT" SERVE YOU?

Be Happy—Be Wise get that EXTRA value choose

GELB

CHEMICAL PROCESSING EQUIPMENT

1—Stokes SS rotary vacuum dryer 3' x 15'

1—Stokes SS rotary vacuum dryer 2' x 6'

4—Vulcan type 316 SS bubble cap column, 3' dia x 18' with 11 trays

1—Foster Wheeler Dowtherm vaporizer, 6,000,000 BTU'S

THE GELB GIRL—OCTOBER 1958

CENTRIFUGES:

1—32" suspended type centrifuge with imperforate basket
3—Tolhurst center slung centrifuges, 40" and 48" with rubber covered perforated basket
1—Baker Perkins type 316 SS Ter Meer Centrifuge, Model HS-24"
1—Sharples #16P pressurite SS super centrifuge

DRYERS:

4—Link Belt steel roto louver dryers, Model 207-10, 310-16, 310-20, 604-20
1—Buflovak double drum dryer, 42" x 120"
1—Stokes Model 59DS steel rotary vacuum dryer, 5' x 30'
1—Stokes double drum dryer, 5' x 12'
1—Louisville rotary steam tube dryer, 8' x 45'
1—Louisville SS rotary kiln, 30" x 28', complete

FILTERS:

1—Oliver horizontal filter, 6'6"
1—Feinc SS rotary string filter, 3' x 3' (NEW)
1—Oliver horizontal 3' pilot plant filter (NEW)
1—Sweetland #7 filter with 20 steel leaves
10—Sweetland filters, #12, with 72 SS leaves
1—Sweetland #3 SS filter
1—Niagara SS filter Model 510-28
1—Shriver SS 18" x 18" plate and frame filter press, 8 chambers

AUTOCLAVES, KETTLES & TANKS:

1—Glascote glass lined jacketed kettle, 500 gal.
1—Lee SS jacketed kettle, 125 gals, 90# W. P.
1—Theo. Walters 500 SS jacketed reactor
1—Nickel jacketed 1000 gal. kettle
1—Patterson steel jacketed 3000 gal. kettle with agitator

MIXERS:

3—Robinson type 316 SS sigma type jacketed heavy duty mixers, 300 gal. 60 HP.
3—Howes 40 cu. ft. rubber covered ribbon blenders
1—Leader SS jacketed 51 cu. ft. ribbon blender

MISCELLANEOUS:

2—Heat Transfer Products steel bubble cap column, 36" and 42" with 5 and 10 trays
1—Acme steel bubble cap column 42" dia. with 10 trays
1—Downington Iron steel bubble cap column, 24" dia. with 14 trays
1—Type 316 SS stripping column 8" x 20'
7—Patterson Kelley, Carpenter 20 SS heat exchangers, 500 sq. ft. each
2—Patterson Kelley, steel heat exchangers, 1000 sq. ft. each
2—Badger type 316 SS heat exchangers, 400 and 480 sq. ft.
2—Bolle & Grossett heat exchangers, steel, 73 sq. ft. each
6—Struthers Wells heat exchangers, 885 sq. ft.
1—Patterson Kelley steel heat exchanger, 427 sq. ft.
50—Steel heat exchangers from 15 sq. ft. to 400 sq. ft.
4—Type 317 SS heat exchangers, 892 sq. ft. each 200 PSI
30—Struthers Wells SS heat exchangers 650 sq. ft. each
1—Struthers Wells type 316 SS heat exchanger, 330 sq. ft.
2—Stokes tablet presses, Model T
1—Bolling 8" x 16" 3 roll laboratory calender
1—Swenson type 316 SS vacuum crystallizer, 3'6" x 12'
1—Swenson type 316 SS vacuum crystallizer, 2'6" x 12'

1—Badger type 316 SS bubble cap column 36" dia. with 8 trays

1—Badger type 316 SS bubble cap column 42" dia. with 11 trays

1—Acme type 316 SS jacketed kettle, 2000 gal.

1—Pfaudler glass lined jacketed kettle, Series P. 20 gal.

Established 1886

R. GELB & SONS, Inc.,

CHEMICAL, RUBBER, OIL, PLASTIC and FOOD PROCESSING MACHINERY

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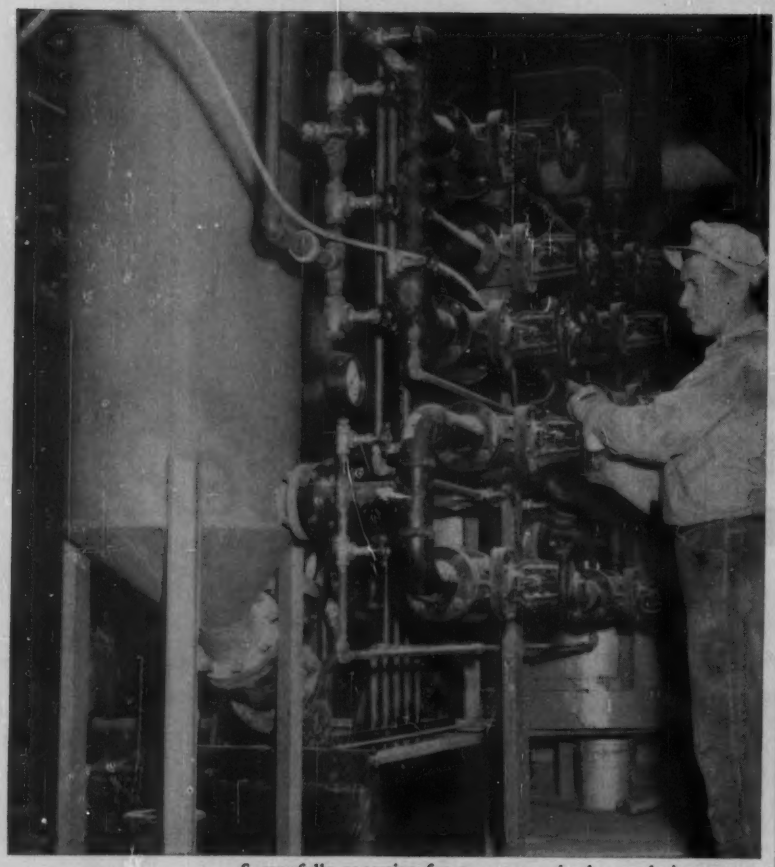

Successfully operating for over a year in the revolutionary new Unit 6 of the Philo Plant of Ohio Power Co., this Croll Reynolds ClaRite feedwater filter using SOLKA-FLOC filter aid has fully borne out its extensive pilot test predictions.

In feedwater purification— iron oxide cut from 200 to 1 ppb with SOLKA®-FLOC Filter Aid

The problem: Purifying feedwater condensate in the first commercial super-critical pressure steam generating plant.

The solution: Pre-filtration of the demineralizer influent to prevent rapid fouling caused by minimum amounts of suspended iron oxide. Extensive pilot tests proved that a filter station using SOLKA-FLOC, followed by a cation resin bed, cut feedwater iron oxide from up to 200 parts to one part per billion.

Whether your field is water purification, or whether it is heavy chemicals, food processing, pharmaceuticals, chromatography, beverages, textiles, plastics, stream pollution, or a long list of others, you can benefit from this versatile filter aid.

SOLKA-FLOC is economical, highly purified, finely divided cellulose. Besides improving filtration rates, it keeps screens cleaner, saves downtime, gives you more economical volume of clarified filtrate with minimum retention of filtrate in the cake.

Added advantages: It makes a stable pre-coat, does not bleed, prevents loss of cake from pressure drops, does not abrade pumps and valves. And SOLKA-FLOC *adsorbs* many metals such as iron, copper, other impurities.

Write us about your specific filtration problems. Address Dept. DFID, our Boston office.

BROWN COMPANY

General Sales Offices: 150 Causeway Street, Boston 14, Mass. *Mills:* Berlin and Gorham, N.H.
Sold in Canada by Brown Forest Products, Ltd., Montreal, Que. (ALPHA-FLOC)

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Photo courtesy Jones & Laughlin Steel Corporation, Pittsburgh, Penna.

Good riddance to bad rubbish —through hose

B.F.Goodrich improvements in rubber brought extra savings

Problem: At this power plant they have to get rid of huge loads of a waste material, called fly ash, every day. It's collected from furnaces, washed, then piped down the side of that building and away to a disposal pit so as not to polute the air or a near-by river. Fine, except that this mixture of gritty fly ash, corrosive acid water, sharp slivers of metal was eating holes through the metal pipe in only six months. Each pipe replacement cost $700 plus about 100 hours of workers' time.

What was done: Company engineers, working with a B.F.Goodrich distributor, decided to replace the pipe with rubber hose specially developed by B.F.Goodrich to handle rough materials. The lining of this hose is made with the toughest, wear-resisting rubber known. The hose is so rugged that it's even used in some places to handle broken glass, chunks of coal, granite chips.

Savings: The B.F.Goodrich hose had been on the job 8 years when the picture was taken. It gulps thousands of gallons of acid water and grit every day, but shows no sign of wear, looks good for many years more.

By lasting 7½ years longer than pipe, plant engineers figure that the B.F.Goodrich hose has already saved $6400 in replacement costs and $4800 worth of maintenance time.

Where to buy: Your B.F.Goodrich distributor has exact specifications for the B.F.Goodrich hose described here. And, as a factory-trained specialist in rubber products, he can answer your questions about *all* the rubber products B.F.Goodrich makes for industry. *B.F.Goodrich Industrial Products Company, Dept. M-451, Akron 18, Ohio.*

B.F.Goodrich *industrial rubber products*

NEW...

Fairbanks-Morse Positive Displacement Axial-Flow Rotary Compressor

Combines the best features of reciprocating and centrifugal compressors

Consider the advantages of the all-new Fairbanks-Morse two-impeller, helical-lobe type, axial-flow rotary compressor:

1 Delivers oil-free air or gas with low ratios of unit weight and space to capacity.

2 Exhibits high efficiencies and positive-displacement stability of flow at varying compression ratios and speeds.

Result: Ideal performance from a relatively small compressor that is mechanically simple, flexible in application, adaptable to any power source; a compressor that provides stable performance, smooth operation, and variable-capacity control.

This all-new F-M Compressor is available in 5 standard case and impeller sizes, single-stage and multi-stage units—for pressure, vacuum or booster service. Capacities range from 800 to 13,000 cfm.—also higher or lower if desired, on custom-designed basis. Contact your Fairbanks, Morse & Co. branch for further information, or write directly to Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago 5, Illinois.

Ask for new illustrated bulletin ACO 100.1 giving typical performance characteristics and other important data.

FAIRBANKS-MORSE

a name worth remembering when you want the BEST

COMPRESSORS • ELECTRICAL MACHINERY • DIESEL AND DUAL FUEL ENGINES • DIESEL LOCOMOTIVES • RAIL CARS • PUMPS • SCALES • HOME WATER SERVICE EQUIPMENT • MAGNETOS

Will you reap the long-term payoff
of good mixer shaft sealing?

If you want to minimize your mechanical fluid mixing costs, take a hard look at *mixer shaft sealing.*

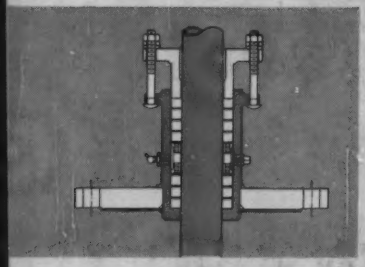
This is the area where profits can leak away unnoticed. The right shaft seal makes all the difference between an efficient mixing operation and a ruinously expensive one.

When you're aiming for low-cost shaft sealing, *don't be fooled* by low first cost. Instead, look for solid long-range savings you can make in terms of *smooth operation, rapid maintenance, minimum downtime.*

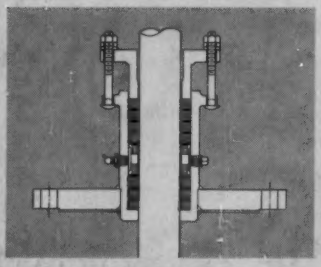
Here are some mechanical reasons why you get these savings with LIGHTNIN Mixers. Every one of the features illustrated below is a LIGHTNIN "first." Many are yours only with LIGHTNINs. And only LIGHTNINs give you *all* of them!

For lowest-cost fluid mixing, see your LIGHTNIN Mixer representative soon. Look him up in Chemical Engineering Catalog. Or write us direct.

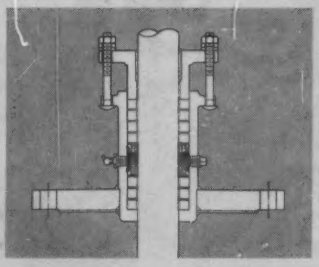
How you cut mixing cost with the *Lightnin* stuffing box



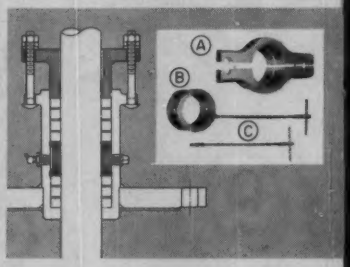
1. SAVE COST of a special-alloy mounting flange with all-welded LIGHTNIN construction. Forged steel flange is faced with correct alloy for your process conditions. Hub is solid alloy. Alloy parts are shown in color.



2. GET SUPERIOR SEALING with 7 rings of large-cross-section packing. Separators facilitate packing removal, distribute force uniformly. Gland bolts, threaded part way, prevent overtightening.

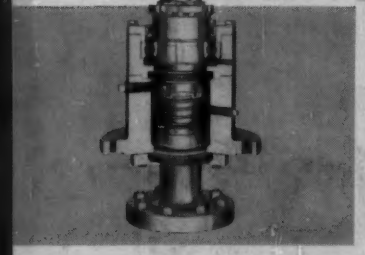


3. GET BETTER LUBRICATION without repacking. Lantern ring evenly distributes lubricant; permits continuous lubrication under pressure; extends time between repackings. Relief plug prevents overlubrication.

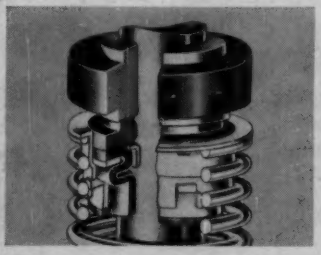


4. REPACK FASTER with exclusive split packing gland (A) that comes right off the shaft to allow maximum work space. Lantern ring (B) lifts out quickly by means of pullers (C), standard accessories.

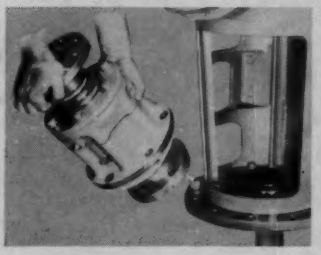
Get simplest possible maintenance with *Lightnin* mechanical seal*



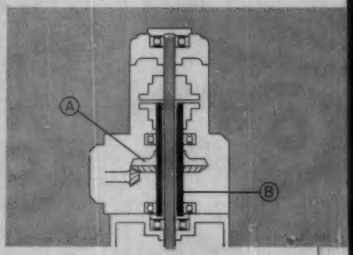
1. ELIMINATE REPACKING and adjustment with this cartridge-type LIGHTNIN rotary mechanical seal assembly, optional on all LIGHTNIN Mixers. It's saving many users thousands of maintenance dollars a year.



2. GET WIDEST CHOICE of seal designs and materials to meet your conditions: stainless steels, Stellite, Hastelloy alloys, bronze, ceramic, Teflon, etc. Handle pressures to 2500 psig and all temperature ranges.



3. REPLACE SEAL ASSEMBLY quickly, if ever necessary—without dismantling mixer or removing it from tank, and *without skilled manpower.* Seal cartridge unbolts, comes out as a unit; replacement bolts in.



4. RETAIN GEAR ALIGNMENT when changing seal. Mixer gears (A) are isolated from shaft by hollow drive quill† (B) *—cannot get out of line* when seal is removed. Shaft realignment is automatic on reassembly.

†patented

WHAT MIXING OPERATIONS are important to you? You'll find a wealth of information on fluid mixing in these helpful bulletins describing LIGHTNIN Mixers:

- ☐ Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP (B-102)
- ☐ Top entering; propeller types: ¼ to 3 HP (B-103)
- ☐ Portable: ⅛ to 3 HP (B-108)
- ☐ Side entering: 1 to 25 HP (B-104)
- ☐ Laboratory and small-batch production types (B-112)
- ☐ Condensed catalog showing all types (B-109)
- ☐ Quick-change rotary mechanical seals for pressure and vacuum mixing (B-111)
- ☐ Confidential data sheet for figuring your mixer requirements (B-107)

Check, clip and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 128-K Mt. Read Blvd., Rochester 3, N.Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ont.

"Lightnin® Mixers"

MIXCO fluid mixing specialists

*patent pending